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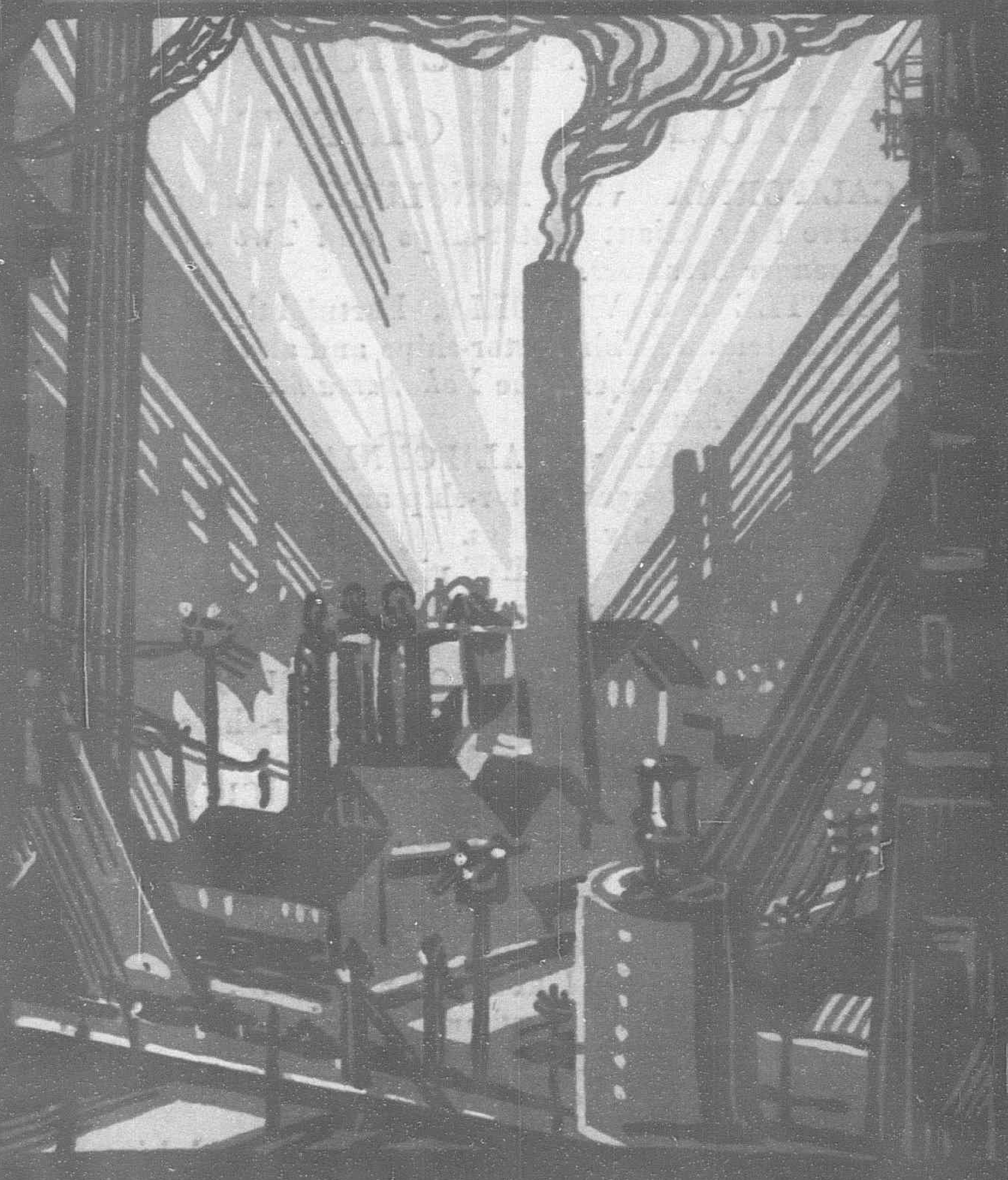
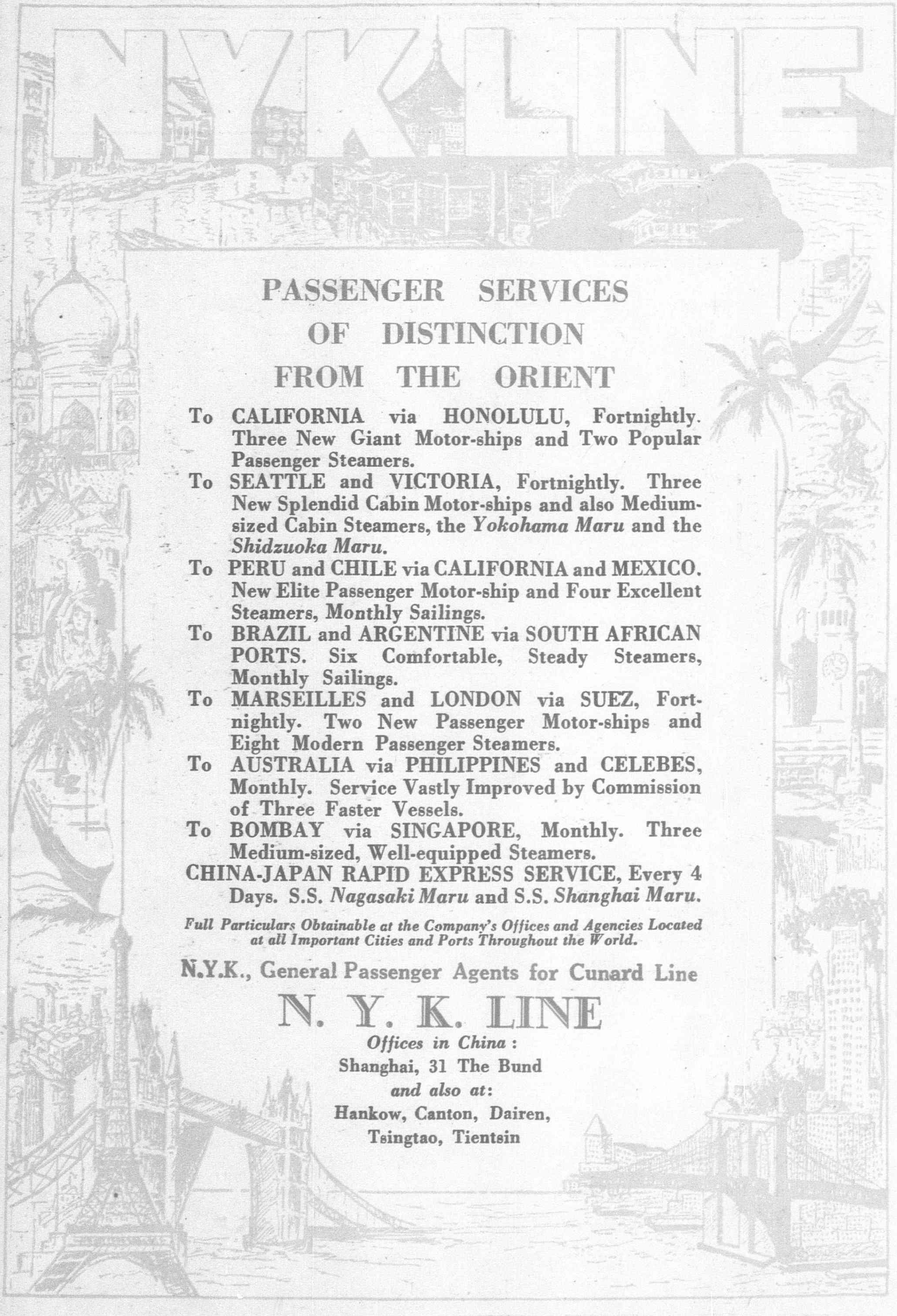


上海黃浦灘念四號

遠東時報

THE ELECTRIFICATION OF CHINA

Vol. XXVII MAY, 1931 No. 5



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The Far Eastern Review

ENGINEERING FINANCE COMMERCE

VOL. XXVII SHANGHAI, MAY, 1931 No. 5

DONNYBROOK

It has been a late Spring. The wheel of Chinese politics revolves with the seasons. Summer is at hand and with it comes the perennial blossoming of the red flower of civil war, massacre, devastation, desolation, hunger, sickness, despair and death. All during the winter months Nanking has been engaged in major military operations to suppress banditry and communism, a task of far greater magnitude than the campaign waged last year to preserve the unity of the nation. Every cent that the Minister of Finance has been able to raise by taxation, loans and other expedients, has gone to defray the costs of maintaining the huge armies upon whose possession rests the power of the Government. For six months, China has enjoyed the blessings of an armistice between the main political factions and even though the campaign of pacification has strained the financial resources of the treasury, the country has reacted in its usual way to these periods of relative security.

The extraordinary recuperative powers of the Chinese people have again demonstrated their will to survive and ability to surmount their economic problems, Industrial development, railway rehabilitation, municipal improvements, port extensions, river conservation and other equally needful constructive undertakings initiated during the last year are evidence of the progress being made in the face of almost insuperable obstructions and difficulties. If Nanking is to be judged by material things, it has fairly justified the recognition, confidence and support extended to it from without.

It is useless and unprofitable to attempt to analyze Chinese domestic politics. It is a vicious circle. The story never varies. Year after year for the last three decades, history has repeated itself, a nauseating recital of political betrayals, double crossings, treasons, civil wars, graft and corruption, in which only the names of the principal actors change as they strut across the stage in the brief limelight of publicity.

As in previous years, so in the summer of 1931, the curtain rises on another act in the long drawn out dismal Chinese tragedy, showing Kwangtung and Kwangsi in revolt against Nanking, setting up another independent government to complicate international relations and postpone indefinitely the unification of the nation. As in all previous uprisings, the revolutionists seem to have adequate reasons for justifying their action. It is difficult for the foreigner to judge of the merits of the case, as our experience is that the whole truth is never revealed. As far as outward appearances go, the impending civil war is merely a prolongation of last year's struggle for the elimination of President Chiang Kai-shek, with the difference that this year instead of a purely sordid struggle between militarists, the issue is one between the civil and military authorities for supremacy. The drastic act of the Military Chief of the Government in forcing the resignation of the Political Head of the Party and depriving him of his personal liberty (thus removing all checks upon his own power) was bound to be resented by the older associates and followers of Dr. Sun Yat-sen. Such an act would have provoked a political storm in the best organized democracy and precipitated a crisis. Unfortunately, China has not yet reached that stage of political development when these arbitrary abuses of power, no matter how justifiable or expedient, can be corrected by an appeal to the people. Dissatisfaction or opposition to the established authority can be effectively voiced only through staging a revolution and a resort to arms.

Under such conditions, China will never escape from the rule of the Strong Man who controls the military forces of the government. Yet if China is to take her proper place in the world on a plane of equality with the other Great Powers, and make its voice and influence felt in the councils of the nations, military dictatorship must be subordinated to the civil power. Viewed from this angle, the present crisis in China is merely another step forward towards the ultimate goal of democracy. Like the mumps, measles or the other ailments that youth has to pass through on the way to maturity, these disorders are symptomatic of the evolution of the Chinese into a modern state.

The outside world is not concerned as to the merits of the present dispute. It may sympathize with Kwangtung in its revolt against the concentration of power in the hands of President Chiang Kai-shek, but at the same time it remembers that the present government was imposed upon the rest of China by Canton. For all practical political purposes, Nanking is Canton.

The Cantonese are evidently akin to the Celts, at all times "agin the government." True to type, they are not happy unless mixed up in a fight and cracking heads, like the Irish at the Donnybrook Fair. All the police forces in the United States are powerless to cope with the Cantonese Tongs when they periodically go on the war path to wipe out their rivals in business. Our Chinese contemporary *The China Press*, commenting editorially on "China's Need of Peace" in its issue of May 19, gives us the following illuminating picture of this characteristic trait in the Cantonese make up:

"*The pitiable feature of China's visitations of war in this century is found in the fact that it might almost be said that the loss and suffering has been without the sustaining consolation that it has been endured to maintain a great ideal, or to accomplish a great object. The warfare has been domestic. Chinese have fought against Chinese, and the victor has always had the distress of the thought that the vanquished was his own blood brother. What has been happening on a nationwide scale has been similar to the feuds that used at one time to exist between villages in Kwangtung. The memory of these feuds would be carried from generation to generation. Every now and again raids would be made by the one village or the other; houses demolished, crops destroyed and general havoc created. Villages that would have been the centers of happy and prosperous communities were periodically wiped out and the part of the countryside affected became a scene of hopeless desolation.*

"*In many places in the interior, civil war and the resultant increase of banditry have brought the population to the verge of ruin—in many instances have hurled them over it. Wealth from production that should have flowed through the regular channels to assist in building up the national frame has either been destroyed or rendered immobile. All the ill effects of the Kwangtung village feuds have been reproduced on a larger scale on a bigger stage—and, unhappily the whole distressing business has been nearly as purposeless.*"

It is difficult for foreigners to take sides in such a purely family fight. All we can do is to regret that such an issue has been permitted to reach that stage where revolt and a declaration of independence pressages another disastrous civil war, at a time when the provinces north of the Yangtze are still overrun with communists and bandit armies, ready to take advantage of any relaxation of military pressure to re-establish and assert their rule. The experience of last year should be a lesson to both Canton and Nanking. The withdrawal of the armed forces of the government from the southern provinces to carry on the campaign in the North,

(Continued on page 272).

Signs of Progress

Some Thoughts on the Electrification of China

By GEO. BRONSON REA

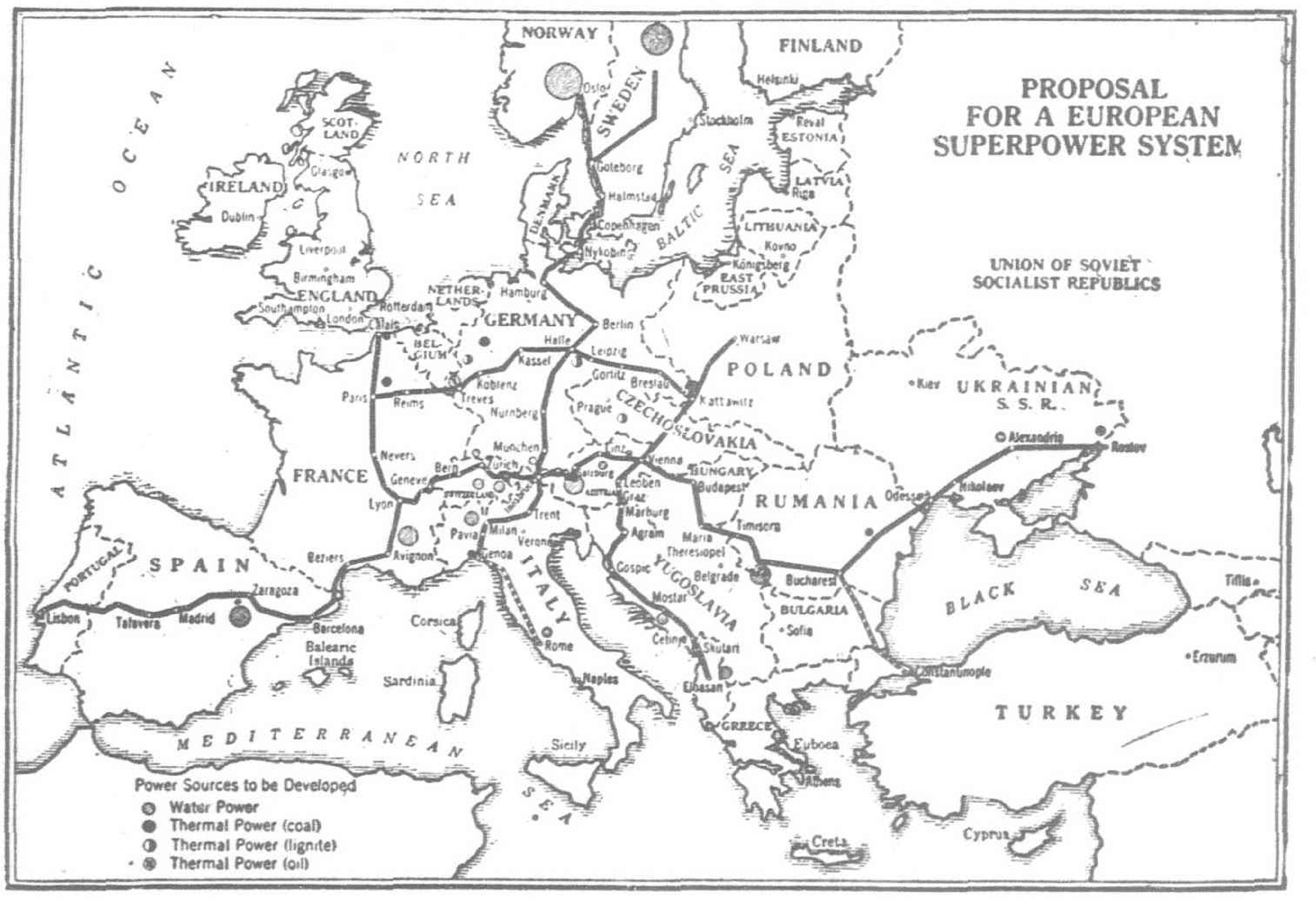
PLANS of prodigious proportions for supplying entire countries and even continents with electric power by linking together the power distribution systems of separated areas are now being proposed. At the World Power Conference held last year in Berlin, Dr. Oskar Oliven, president of one of the most important utility holding companies in Europe (Gesellschaft für Electrische Unterenehmungen) presented a plan that would tie together all the sources of energy in the Continent into one vast super-power network, so that each source shall contribute as it were to a common reservoir.

These super-power systems are already working successfully in various parts of the would, but Dr. Oliven's plan is the first to combine them all into one great continental unit.

In Switzerland, hydro-electric plants are fed by streams of melted snow from the glaciers of the Alps and their flow is diminished by the cold of winter. On the other hand, farther to the south, is a mountain range along the Adriatic Sea which chills the moist air blown from the expanse of waters. Streams thus produced by the precipitation are sources of energy at the very time that the flow of Swiss rivers is reduced by freezing.

Norway has more water power in her streams than her industries can absorb and her southern neighbors would be glad to utilize the surplus, in fact are doing so already to some degree.

In certain sections of Europe coal is abundant, in others there is oil, and in others are falling streams, while by contrast, great areas are lacking both in fuel and in water power. To feed the latter sections from the former is a part of Dr. Oliven's vision and he recommends that many power plants now operating, together with new ones to be built, shall be tied together by a great network spreading across the face of western and central Europe from which all sections, regardless of political boundaries may draw energy for their industries, their railroads and their household needs.



The Oliven Plan For a Super-power European Network; 400,000 volts, $500,000,000 Outlay and 6,600 Miles of Transmission are Contemplated (From The I.G.E. Digest)

It is a great picture, and the map we show portrays its scope. It will be noted that three lines are proposed, running approximately north and south and two lines running east and west are tied in with them. Starting at Calais near coal fields that can be readily supplemented by English coal from across the channel, a line would run through Central France, fed near Lyon by water power plants of the Rhone, on to Barcelona, and across Spain and Portugal, a total of 1,300 miles. Spanish rivers from the Pyrenees and coal landed at the seaport city of Lisbon would feed power to the southern section.

The second line of about 1,900 miles would begin with water powers of Norway and Sweden, cross Germany, passing through its lignite fields on to water power sources of Switzerland and Northern Italy, to Genoa, a coal receiving seaport, and thence probably to Rome.

The third north-south line would start near the coal fields that border Poland and Eastern Germany, crossing Czechoslovakia and Austria, southward to tap the water powers of Yugoslavia along its Adriatic coast. This line would be something over 900 miles.

These three lines would be tied together first, by a line from Paris across Germany through its lignite fields to Poland, about 750 miles, and second, by a line 1,800 miles in length from Lyon over the Alps to Vienna, through Hungary, taking water power from the Danube in Southern Rumania, crossing the Ukraine with its oil supply at Odessa, its water power in the Dnieper River and coal at its eastern extremity, Rostov. A branch of this line could be added from Bucharest to Constantinople.

Politically, the plan is no experiment for already there are power lines that cross many national borders. For example, Switzerland is thus joined with her neighbors on three sides, France, Germany and Austria being her copartners in one of the greatest power zones of the world. In its broader application to embrace more countries, one may vision electric service as a medium through which many nations are joined by new ties of mutual interest, a further step towards international co-operation, goodwill and general peace.

Interesting facts present themselves in the matter of load balancing in so extensive a system. In the summer, it stays light longer in Norway than in Spain and Italy and in the winter the opposite is true. The sun does not set in Lisbon until three hours after it has set in Rostov. Thus twice a day the twilight zone travels from east to west, and with the changing seasons, from north to south and as the dawning and waning daylight shifts, the points of changing load shift also. When the local demand on one power plant of such a system increases, less loaded distant plants make contribution to its area, and on the other hand, as its nearby load decreases, it sends its power out to the aid of other sections.

Dr. Oliven suggests potentials for this great network in the order of 400,000 volts. The transmission distances aggregate 6,600 miles. He figures an expenditure, apart from the plants themselves, of roughly half a billion dollars for interconnection and he estimates three years as the time required to complete financial and international agreements and six years more to complete the undertaking.

It is easy to recognize the difficulties of a technical, financial and political nature that must be overcome, but the economic advantages are considered to transcend all obstacles. The lessened cost of power to the consumer, the greater spread of available power to a multitude of users, the inevitable enhancement of goodwill among participating nations are powerful incentives to the consummation of the plan.

The brilliant plan advanced by Dr. Oliven will probably never be realized, until national rivalries and jealousies are buried in a new pact creating the United States of Europe, a movement, however, that is already underway. On the other hand, Dr. Oliven's plan is only one of the many probable developments in the next decade, a look ahead along sane and conservative lines that will bring electrification into every home, farm and factory, creating robots that will automatize many industries and services now performed by human labor. As a matter of fact, we are now only on the threshold of the Electrical Age, glimpsing some of the great possibilities that the future holds out for mechanizing, standardizing and improving our present methods of production. Electricfication of railways will go forward on a scale unprecedented in order to reduce operating costs to compete with the newer and larger types of buses and aircraft. Coal mines, natural gas and peat deposits and all available water power sources will be utilized to furnish electric current for feeding into great national super power systems. Dr. Oliven has given us some idea of what this will mean when all the present power systems of Europe are combined in one stupendous continental grid, assured at all times of a constant supply and pressure at low cost.

Asia, (excluding Japan) is just entering the first stages of linking up her scattered lighting and power plants into small power systems, and there is much to be done before this continent can dream of executing plans such as have been successfully carried out in Europe and America. Japan, however, has fully availed herself of her splendid water powers, creating a system of hydro-electric plants reinforced by steam power plants that will supply her with cheap power for many years to come. So rapid has been this development, and so intense the competition for territory that we are now witnessing the elimination of many smaller power plants, by amaglamation, purchase or incorporation into the larger companies, the gradual linking up of all these systems into one huge national grid, that will in time be controlled by one or two big corporations.

With this tendency before us, we can begin to appreciate and understand something of the grandiose dreams of the National Construction Commission in layng down a program for the future electrification of China. Due to many causes, China has not kept pace with the rest of the world in constructive effort. Less than 600,000 kw. have been installed in the past thirty years and this total is made up by some 575 scattered generating plants, representing an investment of approximately Taels. 140,000,000. This includes the Shanghai Power Plant with an installed capacity of 161,000 kw. and an investment of Taels. 80,000,000. In the same period, Japan has increased her total capacity of generating plants from 1,500 kw. (in 1900) to over 5,000,000 in 1927. One Japanese company alone (The Tokyo Electric Light Co.), last year supplied 725,000 kw. and its capital stood at Y.407,149,000.

In order to supervise the electric power undertakings in China and intelligently direct the future electrification of the country the National Government created the National Construction Commission with full powers to regulate the erection of all future electric power plants. In addition to its general supervisory functions, this Commission drew up an ambitious program of nation-wide electrification to be carried out in five periods of five years each. On another page of this issue of *The Far Eastern Review*, will be found the general outline of this program with the maps of each area and the estimated costs. The first period provides for the installation of 607,000 kw. at a cost of $310,015,000 (silver) while at the end of the fifth period the total generating capacity is placed at 5,000,000 kw. representing an installation cost of $2,583,000,000. China proposes to accomplish in the next 25 years, what Japan did in the last quarter century. At first glance, the program seems far-fetched and idealistic, but if we assume a twenty-five year period of peace in China, the industrial needs and advance of the country will fully justify such a program.

In any study of China's advance in electrification, it is well to give consideration to the points emphasized by Dr. Dettmar in his report on conditions in this country. Dr. Dettmar, one of the foremost electrical experts of Germany, visited China last year as a member of the German Industrial Mission and conducted a most thorough investigation of the possibilities of the market for German electric machinery manufacturers. His report submitted to the Group of German Industrialists lays stress on many obstacles that must be overcome before China can hope to extend her present power supply along the lines laid down in the program of the National Construction Commission. The salient features of Dr. Dettmar's report are reproduced in this issue of *The Far Eastern Review*.

Aside from the minor and perhaps remediable hindrances to the profitable operation of electrical plants in China, the main obstacle to any rapid growth of power systems is the absence of a demand, that can be created only by the industrial growth of the country. A certain sure and gradual development of existing plants can be looked for in the increase of the requirements for house lighting, ventilating fans and minor motors. There are also many cities, towns and villages that can afford the luxury of electric light instead of candle and oil illumination, and there are several good possibilities for the use of power in coal mines, especially in transporting the product to the main transportation lines. Dr. Dettmar's report while emphasizing the drawbacks to development, on the whole is optimistic as to the gradual and steady improvement of the market for equipment and accessories. The program of the National Construction Commission fully bears out his forecast as to the electric requirements of the country, provided that peace, security and guarantees for capital are forthcoming.

If foreign capital is to participate in this development, the regulations governing private electrical enterprises in China will have to be repealed or revised, as at present such participation is prohibited. As China settles down and emerges from the present wave of intense nationalism that influences the drafting of anti-foreign regulation and is a little more sure of herself, these laws will probably be repealed, but until that time arrives, it is extremely unlikely that any serious foreign investor will hazard his capital in creating undertakings where the power of control is denied to him and which may be seized and incorporated into the state electrical grid, without adequate compensation. It is interesting to note, however, that certain well defined power schemes are being evolved and which in due time will undoubtedly be carried out. The work of the National Construction Commission in developing the Nanking, Tsishuyen and the Hangchow Central Power Stations clearly indicates the efficiency of its supervision as far as actual operating results are concerned.

It seems a pity that in designing and carrying out a power scheme for the Kiangsu and Chekiang regions, the Chinese have deliberately isolated the great Shanghai Power Plant, which is the natural and most economic central station in the territory, as well as one of the best managed plants of its kind in the whole world. In our issue of July, 1929, will be found a complete detailed description of the equipment of this plant as it stood on that date, and in this issue of *The Far Eastern Review*, will be found another authoritiative article on the operation of this plant written by Mr. C. S. Taylor, the capable Vice-President and General Manager of the Company.

The development of this plant from a little one horse station on Fearon Road into one of the largest and most efficiently operated power plants in the world is a matter of great pride and satisfaction to the international community of Shanghai, representing as it does, the continued support, faith and loyalty of the ratepayers in the little group of engineers who year by year enlarged, expanded and improved the plant to its present proud and enviable position in the electrical world.

This plant, developed as a municipal enterprise, was purchased in 1929 by the Shanghai Power Company, an American concern which has adhered to the general policy of those who built it up to its present prominence. The plant stands as a monument of administrative and technical efficiency for the guidance of the Chinese in developing their own super-power systems. It may be possible as time goes on to eliminate it as a factor in the grand national scheme of electrification and confine it in a water-tight compartment serving the needs of the International Settlement. Even under this restriction, its future is assured, as the industrial growth of Shanghai and the increased use of electricity in the shops and homes of the city, will steadily increase its output. It will survive all political complications and continue to justify the faith of investors in its shares and securities, no matter how many independent plants are erected by the Chinese in adjacent territories. It is on a safe and firm footing. It is a source of general regret that this splendid example of modern engineering cannot be utilized as the major central power station of the greater grid for the electrification of the two lower Yangtze and Chekiang Provinces, and it is to be hoped that as political conditions are clarified in China and the power of Nanking becomes stabilized and consolidated that some arrangement can be arrived at whereby the Chinese will become closer associated with an enterprise whose co-operation will ensure to them that success which their plans for the development of their country merits.

It is interesting to note that the Chinese are by no means asleep to those immediate possibilities of water power development that promise adequate returns in capital invested. Perhaps the most important of these schemes is the one for harnessing the Yung River in Kwangtung Province, a source of power sufficient to supply not only the requirements of the City of Canton, but to electrify the whole province. This is an old project, which has been investigated and reported upon by various engineers during the past fifteen years. The main obstacle to embarking on the undertaking has been the lack of an adequate demand for current, but as the requirements of Canton are yearly increasing, the project has again come up for serious consideration.

Mr. J. N. Jenssen, a Canadian hydro-electric engineer representing the Fraser Brace Engineering Corporation of Montreal, recently spent some time investigating this project for the Canton authorities and sumbitted a detailed report and estimate of the costs of installation, based on an initial plant of 60,000 kw. capacity. In this issue, will also be found a general summary of the Kwangtung electrification scheme by Mr. W. F. Gilman, an electrical expert recently connected with the Kwangtung Electric Supply Company in an advisory capacity.

In addition to this scheme, the National Construction Commission is carrying out the preliminary studies for two large hydro-electric plants, one for harnessing the Yangtze River at Sanhsien above Ichang and the other at Lungmen on the Yellow River. The Commission is also collecting records and data concerning the rise and fall of other large rivers in the country in order to determine on the building of electric power plants at other suitable sites. Aside, however, from the Yung River project in Kwangtung and some minor sites in Fukien and Chekiang, there are few available water powers in the country, where the demand would justify their development. The industrialization of the Wu-han cities will in time justify the project for harnessing the Yangtze above Ichang, and the erection of a large power plant that will electrify the Liang Hu provinces.

Several promising electrification schemes might be realized by erecting power stations at various coal mines throughout the country. The possibilities of such electrification are seen in the big power development in the Fushun Mines in Manchuria, described in this issue of *The Far Eastern Review*. By utilizing unmarketable waste and powdered coal, the Fushun Power Plant has become the second largest unit in China, with the prospect of even surpassing the Shanghai Power Plant in its output. All the railways connected with the mines and even part of the main South Manchurian system are electrified and supplied with current from this station. Only the limitations created by international politics and China's determination to obstruct any further encroachments on her own industrial development, prevent Fushun from becoming the largest power center in China. The plant, being a part of the S.M.R. system, is confined to supplying power and current to the railway zone and the mining concession. If it was not for this restriction, the Fushun plant could supply the city of Mukden and all the other Chinese cities and towns in South Manchuria at costs probably far below what consumers are now paying for similar service from the local Chinese plants.

Some day, China and Japan will find a permanent solution to these delicate political problems that will ensure peace and stability to Manchuria. If, and when, some such compromise is arrived at, it is within the realms of possibility that the Fushun Power Plant will become the center of a super power system that will embrace the whole of South Manchuria. On the other hand, the time will come, when the growth of population and development of industries in Manchuria, will justify harnessing the Yalu River, a project that has already received careful attention from Japanese experts, who report that until the demand for power rises to a certain point, the project must be shelved.

One of the most important electrification possibilities in China is centered on the Kailan Mines, where conditions are somewhat similar to those existing in Fushun. The Kailan Mining Administration is already carrying out the electrification of its own railway transport facilities between the mines and its shipping port at Chinwangtao. This scheme might easily be expanded to take in an important section of the Peiping-Liaoning Railway, and supply the cities of Tientsin and Peking with light and power. Here again, questions similar to those which complicate the future of the Fushun Power Plant make difficult the realization of such a scheme. The Chinese are now carrying on an agitation for the purchase of the Kailan properties, and it is hardly possible that they will consent to any further extensions of the company's activities along lines that conflict with their own plans for national development. As indicated by Dr. Dettmar in his report, other coal mines exist in China, where it would be profitable to install power plants for electrifying their own transportation needs and supplying current to such towns and villages that can be economically reached.

In summing up, we agree with Dr. Dettmar in that China offers a brilliant field for the electrical engineer and although progress will be slow it will be steady. For the next few years, developments must be largely confined to expanding existing plants and installing other small units throughout the country, but as time goes on industrialization and the increased needs of the small consumer will call for larger plants and their incorporation into local and provincial grids that are bound to develop along the same lines as in other countries. Everything depends upon internal peace, and the stabilization of authority under a central government. Given this guarantee, development will be rapid, notwithstanding the obstacles that have been created by Chauvinistic legislation.

DONNYBROOK

(*Continued from page 269*).

left the territory open for the rise of the communist power. Before these forces of destruction are suppressed, Kwangtung and Kwangsi embarks upon another "punitive campaign" that will require all the available forces of Nanking to combat, again leaving Hunan, Kwangsi and Fukien open to the "comeback" of the Reds.

The picture is a deplorable one and we can only hope that before it is too late wiser counsels will prevail and a compromise arrived at that will ensure the continuity of government at Nanking, which, despite its faults and shortcomings is the best that China has evolved to date, holding out some hope of ultimately consolidating its authority and finding a solution to the many perplexing and delicate international problems now under negotiation.

In forcing the issue to the point of warfare, Canton is simply playing the game of Moscow. The *Times of Malaya*, commenting on President Chiang Kai-shek's speech at the opening of the People's Convention in which he praised Russia's Five Year Plan, points out:

> **"To turn back to Russia's plans in regard to China. Russia's very definite plan about China is that China should be broken up into numerous Soviet Republics under Russian domination and direction and, if the Chinese leaders continue to quarrel amongst themselves, this inevitably will happen."**

G.B.R.

Coal and Iron Mines near Nanking.—To facilitate the early opening of the Pukow Iron and Steel Works, the Ministry of Industries has dispatched Mr. Wang Wen-hao, technical expert, to conduct a careful survey of the colliery at Leichiakou and the iron mine at Fenghuangshan, near Nanking. It is estimated that a daily output of 1,500 tons of coal and from 500 to 1,000 tons of iron can be obtained from the two mines.

Manchurian Authorities Ask for Permission to Establish Iron Works.—Permission to establish an iron and steel works at Shenyang (formerly Mukden) to supply material for the various railways in Manchuria is sought by the North-eastern Communications Committee, in a memorandum submitted to the National Government. The petition explains that large purchases are made annually from abroad. Appropriate means, therefore, should be adopted to manufacture at home. The cost of running the factory will be jointly borne by the Kirin-Changchun and Kirin-Tunhua Railways, according to the proposal.

The Basic Problems of Japan

"Problems of the Japanese Exchange 1914-1916" by JUNNOSUKE INOUYE, English Version by E. H. de BUNSEN, Published by Macmillan and Co., Ltd.

One of the reasons why Japan's problems have been misunderstood in the past is traceable to what is accepted by foreigners as a national trait of reticence, and while this may have been true thirty or forty years ago, the advent of parliamentary government, free speech and a free press, reveals the Japanese as vocal and as understandable as any other people. The real obstacle to a proper appreciation of Japan's problems arises from the difficulties of translation. At rare intervals, some foreigner with a thorough grasp of the Japanese language sets himself the task of translating into English one of the many works of Japanese statesmen or leaders of thought and the outside world is given an insight into the real problems of the Empire.

One of these exceptional books has recently appeared under the title of "Problems of Japanese Exchange, 1914-16" and all students of world affairs will extend a vote of thanks to Mr. E. H. de Bunsen (a former British Vice-Consul in Japan) for his excellent rendering into English of the series of lectures, on the above subject, delivered by Mr. Junnosuke Inouye at the School of Economics in the Imperial University of Kyoto in 1926. Although Mr. Inouye's purpose was to explain the system of international exchanges and to outline the most salient features of the financial history of Japan during the period under review, in doing so, he described the fundamental problems of the nation in a manner that elevates the book into an authoritative and official document of Japan's national aims and aspirations. The book is so timely and throws such a flood of light on the policies of present-day Japan that it should be read by everybody interested in the affairs of the Far East.

Mr. Junnosuke Inouye, Japan's Minister of Finance

Mr. Inouye is the foremost authority on the economics of Japan, internationally recognized as one of the great leaders of world finance. As President of the Yokohama Specie Bank during the World War period, he took the lead in those spectacular activities which increased the gold holdings of Japan from Y.376,000,000 in 1913 to over Y. 2,000,000,000 in 1919, transforming a borrowing nation into a lender, making possible loans to the Allies of over 650,000,000 (exclusive of over Y. 600,000,000 to various Chinese Governments and individuals). In recognition of these services as head of the great exchange bank, he was promoted to the Governorship of the Bank of Japan in 1919, resigning this post in 1923, at the time of the earthquake, to enter the short-lived Yamamoto Cabinet as Minister of Finance. For a few years he was out of office, devoting his time to educating his financial colleagues and industrialists to accept a readjustment of their business methods based on the raising of the gold export embargo. During this period, he laid the foundation of the policies which have since restored the exchange value of the yen to par and raised the credit of the nation to its present enviable position. He again presided over the Bank of Japan in 1927-28 and in the following year was invited to enter the present cabinet as Minister of Finance. Mr. Inouye has the full confidence and esteem of his financial colleagues in Europe and America and has justly earned the unofficial title of "Genro of the Bankers," succeeding Viscount Shibusawa ("The Grand Old Man of Japan") as the leader of Big Business in Japan. If Japan is to pull through her present economic difficulties, her salvation will depend largely in following the program laid down by Mr. Inouye in his lectures and which now form the basis of his policies.

Mr. de Bunsen points out in his Foreword that Mr. Inouye aims in these lectures, at something more than an elucidation of economic factors and a recital of financial events. He seeks to convey, not only to those whom he was addressing at the time, but to his fellow-countrymen, the message that it is only by the observance of certain principles that the credit of nations, their economic stability, and the well-being of their citizens can be secured; that the suspension of a free gold market infringes those principles; and that it is the duty of Japan—as it will be to her best interests—to revert to it.

Concerning the operation of the gold standard, Mr. Inouye speaks with the authority of one who is a banker, an economist and a statesman, and its most embittered critic will find difficulty in combating his argument that under no conditions, whether of affluence or disaster, can the trade or finance of a nation be safely dependent on its possession of an immobilized stock of gold.

In the first three lectures, Mr. Inouye deals with three separate phases of the financial history of his country between the years 1914 and 1926. In Chapter I he presents a picture of Japan practically at the end of her resources in the opening months of 1914; he proceeds to describe the economic repercussions of the war period as they were felt there—the cumulative embarrassments of a super-abundance of money, balances immobilized abroad, and a rising exchange—and recounts and criticizes the attempts which were made to deal with the problems thereby entailed. In Chapter II he describes the factors which made for the unsound—if outwardly prosperous—conditions which prevailed in Japan during the latter part of 1919, the collapse of March 1920, and the steps which were taken to improve the currency position; in the latter part of this chapter he treats of the question of Japan's balances abroad, with special intent to their connection with the exchange rates, and makes some drastic comments on the way in which they were handled. In Chapter III, after condensing—with Thucydidean brevity—into a few lines, the financial aspects of one of the greatest natural disasters which ever befell his own or any country, Mr. Inouye passes to a discussion of the exchange difficulties which beset Japan after the earthquake of 1923, the decline in the value of the Yen during 1924, and the causes which made for its recovery in 1925.

In Chapter IV he urges the necessity for the re-introduction of the Gold Standard, enumerates the difficulties of the existing position, describes the problems which the removal of the embargo must entail, and indicates the methods by which they might be obviated. In Chapter V he concludes his course of lectures by a review of Japan's exchange position—concerning which he might appear to be unduly pessimistic—and a call to his countrymen to seek means whereby it may be improved. They should turn, he tells them, from thoughts of war and seek their economic salvation in their Mercantile Marine.

Throughout Mr. Inouye emphasizes the gravity of the position arising in Japan through the maintenance of the gold embargo, and the urgent need for its removal, while he utilizes his material to exemplify, *inter alia*, such different aspects of the mechanism and implications of the exchanges as Buying and Selling Rates, the operation and functions of Gold Shipments, Gold Import and Gold Export points, Currency Expansion and the factors which promote it, disparity between the Internal and External Values of a Currency. Artificial Exchange Rates, Exchange Speculation, Bank Rates in their connection with the Exchanges, Government assistance to trade, and the financing of exchange transactions—a class of business which has its definite place in the banking system of Japan.

Under this system the Japanese banks were originally divided into six distinct groups:

Central (the Bank of Japan).
Home Trade.
Foreign Exchange (the Yokohama Specie Bank).
Industrial (the Industrial Bank)
Agricultural,
Colonial (the Bank of Chosen and Bank of Taiwan.)

and in the earlier days of Japan's modern development, this demarcation of functions proved to be a factor of the greatest value, for it enabled the Bank of Japan to exercise a necessary and beneficial control over almost every department of the economic life of the nation at a time when such control was entirely necessary. Specialization of this kind must, however, make for a certain rigidity, and although there had been, during the fifteen years preceding the outbreak of the war, an increasing and desirable tendency on the part of institutions in almost every group to undertake business—in particular that of foreign exchange—other than that devolving on their own class, the banking system of the country had not as yet attained sufficient elasticity to admit of its ready adjustment to the entirely unforeseen conditions which prevailed in Japan from 1914 onwards. Actually there were by then some eleven Japanese banks handling foreign exchange, but except in the cases of the Yokohama Specie Bank and the Bank of Taiwan their operations in this field were either confined, in the main, to financing the business of the trading firms with which they were associated, or were on a relatively small scale. The exchange position was thus, to all intents and purposes, still dominated by these two important banks, and it may be said that the policy which they followed during the war period was, by reason of their close association with the Bank of Japan, an official policy. Mr. Inouye depicts the situation thus created; it is of particular interest, for it reveals the problems in which abnormal circumstances may involve a highly centralized banking system. As he points out, when dealing with the events of the war years in Japan, neither the public nor the bankers knew of any machinery for the proper handling of the vast sums which came so suddenly into their possession, the matter being perforce left, practically speaking, to the Government and to the Central and semi-official Banks. It is, indeed, a curious commentary on the banking organization of Japan that, while it proved fully capable of surmounting the financial strain of the Russo-Japanese War, it should have proved unequal to the task of controlling the flood of money which descended on it some ten years later. It should, however, be remembered that, whatever may have been the variety and magnitude of the difficulties which from time to time have beset her bankers, Japan shares, alone with a small and select group of countries, the honorable distinction of having never defaulted in the full and punctual discharge of her obligations—of her national concern in regard to which there is abundant evidence in these pages.

Eclectic and versatile, Japan has always sought to adopt and adhere to those methods and institutions which are the best; nor in the so doing has she lacked such wise and courageous leadership as has been that of Mr. Inouye. In 1926 he spoke as a prophet in the economic wilderness; in 1929 he accepted, for the second time, the portfolio of Finance in the Imperial Government of Japan; in January 1930 that Government removed the gold embargo.

Chapter I contains information that is of special interest at this time when restoration of confidence in China's credit hinges largely upon her recognition of outstanding obligations. So much has been written about the so-called Nishihara Loans to the Peking Government, that the following brief reference by Mr. Inouye to these transactions will help to understand the Japanese attitude towards these Chinese investments:

"I already have said that in countries such as England, France and Germany, the man in the street is a foreign investor, and that this enables those countries to dispose of their balances abroad. In countries such as these the public takes up foreign loan issues or invests in overseas enterprises, and the amount of money thus invested by British and French investors runs to a vast amount. Japan, however, lacked experience in financial operations such as these; the nation had, in fact, never been wealthy enough for people here to indulge in such investment. During the war period there was a lot of talk about how we ought to invest abroad, but a nation cannot acquire discrimination in such a matter all at once, and to all intents and purposes no such investments were made by this country. There was, however, a certain slight movement in that direction—such, for instance, as that which was made in the days of the Terauchi Administration, which placed the so-called Nishihara Loans. These were certain loans made to China, and were tinged with a definitely political flavor. I criticized them at the time, and I fancy that those people who advocated the placing of these loans are now very sorry that they did so, for the net result of these operations is apparent when I tell you that in this year's (1926) Diet, the Government was forced to consolidate a loss of Y .100,000,000, plus interest, in respect of them.

Such were the very regrettable circumstances which went against anything in the nature of foreign investment and under which that slight amount which was thus invested has become a dead asset to-day. These investments with the Central and Provincial Governments of China—investments running to several hundred million Yen—resulted in a dead loss, and to-day Japan can recover neither the capital which she thus locked up nor one penny of interest on it. To put the matter in a nutshell, I would say that foreign investment was not practised by this country, and that such trifling investments as were effected might just as well have been thrown into the sea."

In an Appendix, Mr. Inouye gives the total foreign investments of Japanese capital up to December 31, 1924, as follows:—

CHINA		
Investments in corporate and individual enterprises:		
In South Manchuria	631,224	
Other	161,941	
		793,165
Bad Debts:		
Chinese Government	434,044	
Provincial Governments	18,079	
Private individuals	140,521	
		592,644
SOUTH PACIFIC AREA		
Investments in plantation undertakings in Malay Peninsula and East Indies.	108,896	
Investments Philippine Islands	3,684	
In undertakings other than plantations	21,375	
		133,955
RUSSIA		
Due by Russian Government for munitions	70,288	
Russian Treasury Bonds issued in Japan	221,667	
		291,955
		Y. 1,811,719

According to Mr. Inouye, Japan made over Yen. 3,600,000,000 during the war and out of this nearly a billion was wiped out by her unproductive loans to China and Russia. The object of Mr. Inouye's lectures was to emphasize the fact that Japan has always been and will for a long time continue to be an importing national with the balance of trade against her, and this cannot be remedied or permanently changed by continual tariff tinkering to protect home industries. Mr. Inouye finds that in order to rehabilitate the national credit on a permanent basis and prevent the depletion of the gold reserve, that the invisible returns must be brought up to at least Y. 300,000,000. He says :—

" Year after year Japan has been importing more than she has been exporting ; year after year her invisible expenditure has tended to exceed her invisible revenue, and this has meant for her a perpetual shortage of money wherewith to pay her bills abroad. That, Gentlemen, is our position to-day, and we must ascertain how much we require in order to meet that annual shortage . . . what additional income, apart from anything it may be getting from its international trading operations—whether visible or invisible—must this country attain in order to rehabilitate its credit in the counting-houses of the world ? I give you my figure, Gentlemen . . . Y. 300,000,000 per annum."

His attitude towards the entrance of foreign capital into Japan is of supreme interest at a time when nationalism in China is also strongly opposed to foreign investment in industrial and other enterprises. Mr. Inouye says :—

" For the past year or so we have had to listen to a loud and insistent outcry against the entry of foreign capital into the country, the idea behind this apparently being that if you borrow money outside the country you will have to pay interest on it, and your international debit account will be made the heavier by the amount of the interest you thus have to pay, and this will mean that your accounts will be on the wrong side ; therefore do not borrow . . . in such wise do our blatant patriots go on and tell us how, if our legislators will not stop this entry of foreign capital, they will see that it gets the cold shoulder here. To those who indulge in this variety of cheap sentiment I have my answer ; that I cannot see Japan as a country which has any possible chance of becoming an excess exporter for a very long day to come ; that you cannot restore conditions here merely by poring over the Customs Returns. We must look ahead—ten years, twenty years ahead—and shape our course accordingly. I do not see how we can abandon those landmarks of our trading policy by which we have steered for sixty years or more, but I say that mere blind adherence to them will lead us no further towards restoring our international credit. I say more ; I say that anyone who is so blind to the cardinal principles of international finance as to seek to hamper and to preclude the entry of foreign capital into Japan is doing a disservice to his country."

The policy of the present cabinet, is ably set forth in the following summary of basic problems :

" The energies of the Japan of the past found their expression in martial activity, but the world in which we are living now is a world which is withdrawing its sanction from war and warlike ways ; the call on the Japan of to-day is for activity not warlike but economic, and what Japan lacks is room in which to deploy it. This, our island home is small, it is overpopulated, and the mentality of its inhabitants is in danger of atrophy merely through lack of space for its proper development—to the very grievous deterioration of their ideals. It is on this, Gentlemen, that my entire thesis is based, and it is this which makes me say that, if we here any thought for the future of Japan, we must realize, and realize fully, these essential characteristics of the national mind and its needs."

" We have seen that the Japan of the near future cannot hope to become an excess exporter, that is unable to invest abroad and that her invisible trading receipts are dwindling. Granted these premises, granted that to rehabilitate her world finance she requires an additional income of Y. 300,000,000, it remains to see whence she can succeed in producing it. I see one source and one only which she might tap, and that is her deep-sea carrying trade."

Mr. Inouye proceeds to advocate the building up of an efficient mercantile marine as one of the means whereby the invisible returns can be increased. Japan is firmly launched upon this new line of national activity, and as the world business depression is improved and Chinese conditions become more stabilized, the new fleets of the leading Japanese shipping companies will be in a favorable position to reap the benefits.

G. B. R.

Electrical Engineering in China

From the Report of Prof. Dr. ING. DETTMAR of Hannover. Member of the German Industrial Mission

Last year at the invitation of the National Government, a German Industrial Mission visited China to carry out investigations that would serve as a basis for proposals for the economic and industrial development of the country. After a tour covering all the principal business and industrial centers, the Mission returned to Germany and submitted a report to the Central Association of German Industrials concerning the results of their investigations. Of special interest is the report of Dr. Dettmar, the Electrical Engineering Expert of the Mission, parts of which were published by the *Elektrotechnische Zeitschrift*, of Berlin.

Commenting upon Germany's participation in the electrical trade of China, Dr. Dettmar points out that German manufacturers are now supplying 11.5 per cent of her requirements, and there is no reason why this demand should not be increased. It comes as somewhat of a surprise to learn that Japan furnishes 33 per cent of China's imports of electrical material, against 17 per cent from England, and 16 per cent from America, with Germany in fourth place. Dr. Dettmar deduces from the above figures that there exists good prospects for Germany to increase these sales as soon as business conditions are more stable.

The electrotechnical articles supplied to China by Germany include about 25 per cent cables and insulated wires, 14 per cent telegraph and telephone apparatus, 10 per cent incandescent lamps and 9 per cent machinery. Dr. Dettmar says that the great advantage Japan possesses is due partly to the proximity of this country and partly to cheap material. Although the superiority of England and America is not great, the imports from these countries are growing rapidly. A considerable increase in these figures is to be expected unless greater efforts are made by German manufacturers to secure their share of the orders. He believes that there exists a great opportunity to attain this aim.

When considering possibilities of establishing business relations with China in the electrotechnical line, he says that it is necessary to bear in mind the peculiarities of the country which have no parallel whatever in Germany or in other markets. In the first place, is the enormous size of China, larger than the whole of Europe. The consumption of electricity being extremely limited, he points out the difficulties in creating a uniform supply in a country of such huge dimensions, whose present entire production per head of population is only about one hundredth of the corresponding figure in Germany. China at present lacks the necessary economic conditions which would make possible distribution by means of large power systems and in his opinion, it will be several decades before development will justify such a program.

It is not so much the density of population that explains the extremely small consumption of electricity, but the great poverty of the Chinese people and their unusually meagre wants. The average income is too small to allow for any expense except mere subsistance and it will be a long time before conditions change to such an extent that the major part of the population can become consumers of electricity. Owing to these basic conditions, the demand for electrotechnical supplies as compared with other countries, will for some time be limited. In view of the immense size of the country, however, a considerable increase in the demand for electrotechnical articles can be expected in the near future. On account of the peculiar conditions described above, the electricity works in China at present are mostly small units. There are, however, a few moderate size long-distance systems.

There are many other peculiarities which must be considered in comparing the state of electrical engineering in China with that of other countries, such as the great lack of engineers, technicians, wiremen and skilled workmen, absence of adequate roads, railroads, and other accommodations facilitating the transport of fuel, spare parts, etc. Then there are financial questions as well as the great difficulties involved in every attempt to come to a business arrangement with the Chinese. The peculiar slowness with which business negotiations in the Far East and especially in China are carried on before an agreement is entered into, is entirely different from the usual practice in Europe or North America. Much time is always wasted, especially under the conditions prevailing in China to-day, before a project comes to such a stage when it is considered fully ripe to be accepted and carried out. A proposition that in Europe would take a few months or a year or two to consider, often remains undecided in China for many years. Instances are not rare when a simple project has been considered ten or even more years. Another obstacle in winding up a transaction is the Chinese language and also the vagueness of Chinese jurisdiction.

Many Chinese are guided by the principle of buying the cheapest article without regard to quality. Only when an article bearing a well known trade mark or "Chop" has been enjoying a good reputation for a long time and there exists no doubt as to its genuineness, is the price paid. Otherwise, cheaper articles are preferred.

Another fact which makes existing conditions still more unfavorable for the construction of electric plants and their maintenance, is the loyalty of the Chinese people to family and clan, a custom which has existed for thousands of years. Everybody who erects a plant or is employed therein, tries to provide a job for as many of his relatives as possible, with the result that the staff is altogether too numerous.

While formerly no reliable particulars were available concerning the existing electric plants in China, the National Construction Commission has compiled "A Statistical Investigation of Electric Power Plants in China."* The statistics show that by the end of 1929, there were in China

Private Electric Power Plants	523
Plants owned by Authorities	17
,, ,, Foreigners	35
Power Plants for Factories	149

The number of electric power plants has increased considerably during recent years as from 1917, when there were only about 90 public plants in the whole country. This means that the number of the plants has increased more than six-fold.

As to capacity, the following figures are given :—

Private Plants	206,138 kw.
Plants owned by the Authorities	47,840 ,,
Foreign Plants	273,272 ,,
Factory Plants	308,126 ,,

Out of the whole number of plants, there were owned by :

Private Firms	72.3 %
Authorities	2.3 %
Foreigners	4.8 %
Factories	20.6 %

As far as capacity is concerned, the respective rates of percentage are as follows :—

Plants owned by Private Firms	24.7 %
,, Authorities	5.7 %
,, Foreigners	32.7 %
Plants for Factories	36.9 %

After eliminating the factory plants, there were in China by the end of 1929, altogether 575 public electric power plants with a total capacity of 527.2 40 kw. Out of this number, there were owned by :—

Private Firms	91 %
Authorities	3 %
Foreigners	6 %

As the capacity, the respective figures are as follows :—

Plants owned by Private Firms	39 %
,, ,, ,, Authorities	9 %
,, ,, ,, Foreigners	52 %

Capital invested in the public electric plants and the respective amounts are as follows :—

Private Power Plants .. ..Mex	$ 55,407,294.00
Plants belonging to Authorities	16,795,082.00
Foreign Plants	148,822,183.00
Total .. ..Mex	$221,024,559.00

The statistics in question do not give any information regarding output. However, according to the opinion of several competent judges, the yearly output, including the factory plants, can be estimated at about 2 Milliard, *i.e.* about 4,5 h.Wh per one inhabitant. The corresponding figures for Germany would be about 31 Milliard h.Wh for the yearly production and 490 h.Wh for one inhabitant. As to the share of electric work proportioned to one inhabitant, the Chinese figure is also less than 1 per cent of the corresponding value in Germany.

There exists only a few distribution systems in China, all of which are comparatively small. A certain part of these are located in Manchuria. These nets are as follows :—

Chapei Electricity and Waterworks, Shanghai	33 k.v.
Yunnanfu.	23 ,,
Tsishuyen.	35 ,,
South Manchuria Electric Co. (Japanese)	44 ,,
Pataohao (Manchuria)	35 ,,
Dairen (Port Arthur) (Japanese)	35 ,,

The lines going from Tsishuyen to Wusieh and Changchow, are to form in future a part of a long distance net that will extend on one side up to Nanking, and on the other side to Shanghai and Hangchow.

Most of the existing plants are driven by coal, and a few by oil. Only about 1 per cent of the existing water power (about 20 million h.p.) has been utilized, due to the fact that the most important water resources of China are too remote from the areas of supply for economical transmission under the existing conditions. Then there are no roads facilitating transportation of construction machinery, turbines, generators, etc. Coal, on the other hand, is to be found all over the country, though the number of existing mines is still limited and the railways are little developed. However, there are many coal deposits favorably situated near regions of consumption with the necessary conditions for electric transportation of the product.

Another striking feature of Chinese electric plants is the lack of coal handling equipment. Even the new Chapei plant with a capacity of 20,000 kw. (which was not yet completed when I was there), has no such installation. It has been, however, constructed in such a way that a coal handling plant can be installed later on. The explanation is that coolie labor is much cheaper, coal being carried in baskets by coolies from the wharf to the boiler; though hand wagons are sometimes used for this purpose. The only electric plant in China having an automatic coal handling installation is the great power plant in Shanghai with a capacity of 160,000 kw.

Conditions in China as far as distributing nets are concerned are peculiar. The nets are made in such a primitive way that one cannot imagine anything like them in Europe. Even in large towns there are only aerial lines which are badly strung and badly maintained. Only in very large cities do the plants run all day and night. In smaller towns current is supplied from sunset until about 2 a.m. and many lamps are installed without switches. Even when switches are installed, they are generally not used. On very hot days, the load is heavier from 2 p.m. because of the large numbers of fans in operation. During this time, those lamps which have no switches burn uselessly all afternoon. Consumers buying current at flat rates do not bother to switch off their lamps.

The lines are too closely spaced and exposed to incredible pressure fluctuations. It often occurs that a circuit which has been calculated for 220 v. actually has a tension of 90 v. or even less. If a 220 v. lamp does not give sufficient light, another lamp of 110 v. or even 65 v. is added. When the pressure drops (which occurs as soon as the shop illumination is switched off), the lamp is again changed.

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* Published as a supplement to *The Far Eastern Review*, July, 1930.

The consumption of electricity as indicated above, being comparatively small, a great extension of existing plants may be expected. Many new plants will also have to be constructed. Naturally, only small plants supplying electricity to one locality will be needed in the near future. The construction of long-distance transmission lines and larger plants are possible for some time to come only in places with highly developed industries.

The fact that in villages and small towns, candles and oil lamps generally are still used, shows the great deficiency of the existing electric supply. The absence of gas-works will make it possible for China to entirely pass over this stage of development, and call into existence many smaller and also some middle-sized and larger electrical plants.

Dr. Sun Yat-sen's program laid greats tress upon the electrification of the country, and following their leader's wish, the National Government created in the Spring of 1928 the National Construction Commission, to supervise the construction and operation of plants over all the whole country.*

One of the greatest obstacles to the electricfication of China lies in the fact that a large part of the electricity supplied is not paid for, resulting either in too high prices charged for the current or in an adverse balance sheet. At Canton, Dr. Dettmar found that only about 30 per cent, at Tsinanfu about 40 per cent and in Peking about 40 per cent of the electricity supplied was actually paid for. The explanation is that those plants owned by private firms or joint-stock companies have to supply current free of charge for street illumination and for government offices, also to the employees and workmen of the plant, as well as to the relatives of the owners and those lending money to the enterprise. In this connection, it must be remembered how wide the relationship among the Chinese is. Further, large number of connections are made "at flat rates," and as these consumers never switch off their lamps they naturally consume more than the specified allowance. Then again, a great many bills are never paid and a large number of connections are made secretly without the knowledge of the management, which again means considerable losses. During festivals which sometimes last many days, as during the celebration of the Chinese New Year, all current needed for special illumination must be supplied free of charge.

In addition to these handicaps, the municipal and other authorities enforce reductions in the rates. The cumulative result is often, a lack of necessary funds for maintaining the plants. For instance, the municipal authorities of Canton ordered the tariff to be reduced from 25 cents to 20 cents, though only about one-third of the electricity is paid for. On the other hand, the National Construction Commission who own and operate the Tsishuyen plant has taken measures to ensure the payment of 85 per cent of the current produced.

Below are given existing prices charged by some Chinese plants for electric current :—

Canton	20 cents.
Wusih	16.2 ,,
Changchow	18 ,,
Shanghai, Chapei	18 to 10,8 cents
,, Nantao	10 to 10,8 ,,
,, Pao Tang	32 to 22 ,,
,, Hsyani Hwa	18 to 10,8 ,,
,, Pao Miag	23 to 16,1 ,,
,, Chen Loo	23 to 13,8 ,,
,, Power Company	15 to 9,2 ,,
,, Compagnie Francaise	18,2 to 13,6 ,,

Another obstacle to the development of electrical supply in China has arisen in consequence of the seizures of the Tsishuyen and Hangchow plants by the National Construction Commission. This enforced nationalization has shown itself to be a hindrance to the construction of new plants, as there is no guarantee that similar seizures will not follow in future. It appears that the National Construction Office as well as the Government have realized that such an uncertainty of proprietary rights is a great hindrance to the industrial development of the country and it is to be hoped that the law will be repealed. Until this is done, it is advisable for foreign investors always to secure a sufficient guarantee to prevent such action, as otherwise a pretext for wilful confiscation like those above mentioned, can easily be found in a country in which no real legal rights as yet exist. If, however, investments are made with foresight and an adequate guarantee for future payments secured, China will offer a vast field for foreign capital as far as the construction of electric plants and distributing nets is concerned. Private plants, under the supervision of intelligent municipal or provincial officials, yield a good revenue if properly managed, as no difficulties are created by the authorities. The demand for electricity being unusually great, the supply increases rapidly and in a short time the plant becomes profitable. In many places the installation and lamps are not sold but only hired to the consumer, which increases the profit.

Most Chinese plants are strictly for lighting purposes, a connection for small ventilating fans being arranged for during the summer season. There are only a few plants supplying power, such as the great power plant in Shanghai and the Tsishuyen plant, which carry a heavy daily load. Most of the other plants show very bad loading curves.

Substantial improvement in the electrification of China will be attained as the number of motors increase, with industrial development. No great expansion can be expected in this line as long as coolie labor is so much cheaper than the machine. Child labor is also used in China to a considerable extent. The low wages of the Chinese worker, makes it uneconomical to use machine equipment. In the silk producing districts near Canton, a female worker receives for 11 to 11½ hours work about 40 pfennigs according to the rate of exchange of last year. It is impossible for machines to compete with such labor, unless the production output is large enough to warrant the expense. It is therefore only in spinning-mills, weaving factories, cement works, sugar mills and similar industrial plants that machine equipment is profitable in China to-day. In the foreign settlements, wages are somewhat higher and with an upward tendency.

Conditions, however, vary in different parts of the country. Near large towns and especially along the coast, a motor can sometimes compete with the coolie. Entirely different are conditions in the interior where the wage rate is very low and the transportation of machinery very costly. The technical staff must also be well paid, otherwise nobody would be willing to go to such distant places. Another explanation for the small number of motors in use is because most of the plants supply current during the night hours.

At Tsishuyen, however, a large number of motors are used for irrigating rice-fields. The transformers are stationary while the motors which are portable, are erected in the fields only during the season. Foochow has also been successful with motors for irrigation purposes and Hangchow is expected to follow the example.

There exist in China two Government regulations which deserve mention. The "Regulations Concerning Electric Enterprise" contain provisions governing the permission for organizing a company, its registration and the selection of sites. There are also requirements as to how crossings of rivers, roads, etc, as well as pruning of trees. The regulations for control of public utility plants owned by private firms prescribe qualifications as to the competency of the various officials. Requirements are set forth regarding reports to be submitted to the authorities as well as compulsory reductions of tariffs when net profits exceed 25 per cent of the invested capital. There are further measures which can be taken against a badly managed plant. Also one prohibiting the participation of foreign shareholders. Finally, there is given an intimation to the effect that the authorities reserve the right to take over a plant after 20 years at a fixed price.

From the above, one can see that the official regulations are not calculated to promote a systematic development of electric light or power. No protective measures have so far been established to prevent the stealing of current which is carried on in China to a large extent and against which energetic measures must be taken. The same applies to the stealing of wires. Furthermore, the regulations regarding a free supply of current must be re-considered most carefully. Unless this privilege is reduced considerably, the operation of electric plants can hardly be put on an economically safe basis, as too many people are allowed to interfere. Besides the above mentioned laws, there seems to be an urgent need for additional regulations. Perhaps it would be more advisable to consider the adoption of a special electricity law under which all essential points would be carefully considered and the situation clarified.

At present only a few regulations exist as to the technical operation of electric plants, but even these are not followed. Plants are built according to individual judgment, *i.e.* in the cheapest way possible. Little or no attention is paid to the quality of material with the result that the plant after a short time does not run properly. The lowest quality material generally is used.

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* The program for the Electrification of China drawn up by this Commission appears in this issue of *The Far Eastern Review*.

Illuminated advertising is of great importance in China and is used to a very large extent. This kind of advertising has proved to be very attractive and effective, especially in the large towns. As to motors, apparatus, etc, the simplest and most solid types are to be recommended as, owing to the scarcity of experienced workmen, necessary repairs are difficult to execute.

Electric tram-lines in China are operating in the following cities: Shanghai, Tientsin, Peiping, Mukden, Harbin, Dairen (Japanese) and Hongkong (English). The scarcity of tramways is due largely to the fact that ricshas have proved to be a very suitable and popular vehicle, while another reason is that the streets of Chinese towns are very narrow and with many angles. In most cases, a tramway project meets with too many difficulties to be realized. The conditions, however, are likely to improve in future as broadening of streets and building of bridges are now being planned everywhere.

In the construction of telegraphs and telephones the National Government has shown great activity. While some progress has been made in wireless communications, the development of telegraphy and telephony has been rather slow. There still remains much to be done in this field as shown by the fact that the imports during the few years past amount to as much as six million marks.

While telephone exchanges exist in many towns, the number of telephone subscribers in the whole of China is only about 120,000, 70 per cent of which are residents of Shanghai, Peiping and Tientsin. The number of telephone subscribers is only about 0.5 per cent of the telephone connections of the world. China has only three connections for 10,000 inhabitants against 400 connections in Germany and 1,500 in the United States. The existing telephone lines have a total length of some 315,000 km. In addition, there are about 1,183 telegraph stations with a total length of 100,000 km. In this field, considerable extensions can also be expected in the near future.

While the ordinary telephone and telegraph plants have always been under the direction of the Ministry of Communications, the radio plants were for some time under the National Construction Office, but on August 1, 1929, these plants were transferred to the control of the Ministry of Communications. The number of radio plants in China is comparatively large, due to the fact that they were built for military purposes during the period of civil warfare. At present, there are about 30 radiotelegraphic stations besides a few large ones, the construction of which is in the preparatory stages.

A considerable demand for pocket lamps exists in China because of the lack of illumination in the streets of the interior towns. The lamps offered for sale are largely supplied from America. The manufacture of electrical accessories is conducted on a small scale, embracing small sized generators and motors, lamps, telephone and radio apparatus.

As soon as internal conditions are stabilized, China will succeed in obtaining considerable credit from abroad. China is fully entitled to obtain such a loan for the reason that the present debt, counted per head of population, is unusually small. Further, it should be noted that the rate of taxation per inhabitant is also very low and can therefore be raised considerably as soon as conditions have settled and the power of the government is firmly established. This stage having been reached, China will doubtless be in a position to offer the necessary safety to foreign capital which will then flow freely into the country for the construction of tramways, electric, telegraph and telephone plants, waterworks, factories, etc. All this will mean an improvement in economical conditions and a rise of general prosperity. Another important factor is that a considerable amount of Chinese capital has been invested in the foreign concessions. This domestic capital will be available as soon as peaceful conditions are assured.

From the above report, it can be seen that only inconsiderable results have been attained in the development of electrical engineering in China. Comparatively few places have electric plants. The consumers, (almost exclusively for illumination and small ventilators), are relatively few. In many towns and in the country, candles and oil lamps are used. In spite of the fact that the income of the majority of the population is very low, the consumption of electricity can be considerably increased in future if the wide circles of the population which have so far been excluded, are taken into consideration. Chinese buildings being what they are, an increase of electric supply will mean added safety against fires. Besides, the Chinese are very fond of advertisement illumination which can be seen in front of many warehouses, shops, etc. As a result of an increase of wages, the importance of illumination as well as that of electrometers, will increase. This will again mean that the loading curves of the plants will gradually improve. Finally, with the industrialization of China, a rapid improvement in electrification can be expected. The same applies to telegraph and telephone plants, where great development will inevitably follow to take care of the growing needs.

To sum up, China offers a vast field for activity in the line of electrical engineering, but those interested should use all necessary precaution as, under conditions prevailing in the country at present, there is still much risk involved in undertakings.

Chinese Government Electric Works

ONE of China's great hopes as an element of national reconstruction is to create an actual electrical industry and thus to divert to home producers the profit and prestige of that swiftly growing trade in electrical supplies from abroad which between the years 1924 and 1928 increased from Haikwan Taels 9,000,000 to Haikwan Taels 12,600,000. The rate at which this trade is expanding may be estimated from the report that the consumption of electricity for all purposes in China increased five hundred per cent in the past decade.

Although lesser sporadic electrical enterprises have been started from time to time within the past twenty years, no major step in electrical manufacturing was taken until about a year ago when the National Construction Commission of the Nanking Government took over a manufacturing plant at Kiaochangmiao, Nantao, in Shanghai.

With the hope of growth from this nucleus the Commission now is planning a far more ambitious enterprise in electrical manufacturing and visions in the future a great modern plant to be erected at a cost of $10,000,000. It is hoped to obtain half of this capital from foreign investors with half to be subscribed by the Commission.

The existing Nantao plant, known as the Chinese Government Electric Works, deserves mention. This establishment has a land area of about ten acres affording ample space for the contemplated expansion. It is advantageously located adjacent to the Shanghai-Hangchow-Ningpo Railway and extends to the Bund on the Whangpoo River. The plant up to the present has been engaged in the manufacture of radio equipment and smaller electrical apparatus. An immediate development that is planned is the building of an incandescent bulb plant at an estimated outlay of $500,000.

In connection with the contemplated major project it is intended to allot the capitalization of $10,000,000 as follows:—

(1)	Land and Factory Building	$2,000,000
(2)	Machinery	3,500,000
(3)	Light Railway (Rail and trains)	500,000
(4)	Preliminary Expenses	100,000
(5)	Running Capital	3,500,000
(6)	Educational Expenses for Engineers and Fitters ...	200,000
(7)	Miscellaneous Expenses	200,000

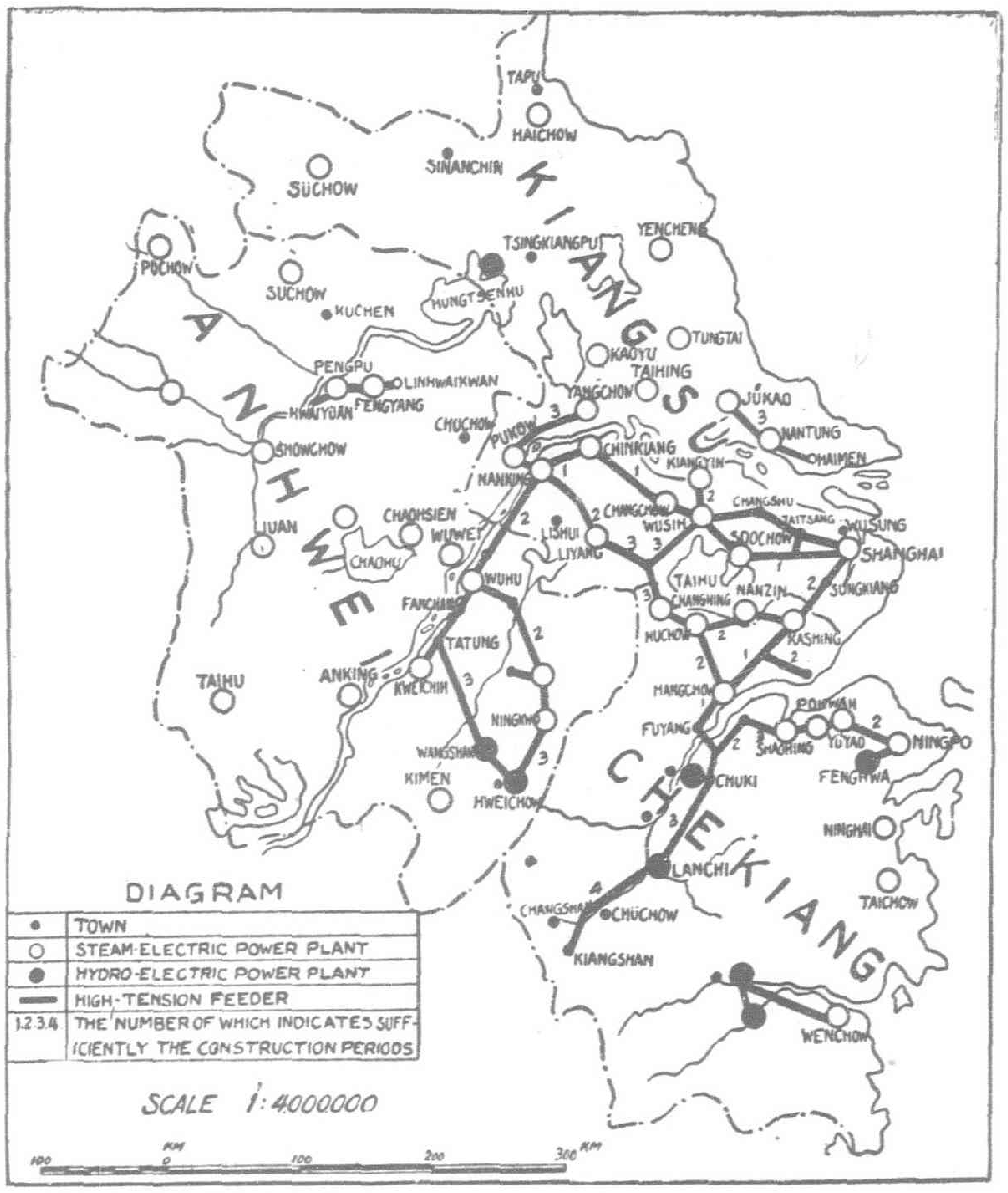
As the plant is expanded and developed, a process that is to be assisted by foreign technical advisors, larger and more elaborate equipment will be manufactured. How ambitious the project is may be seen from the list of products in view for future manufacture as follows:

(*A*) *Machinery*

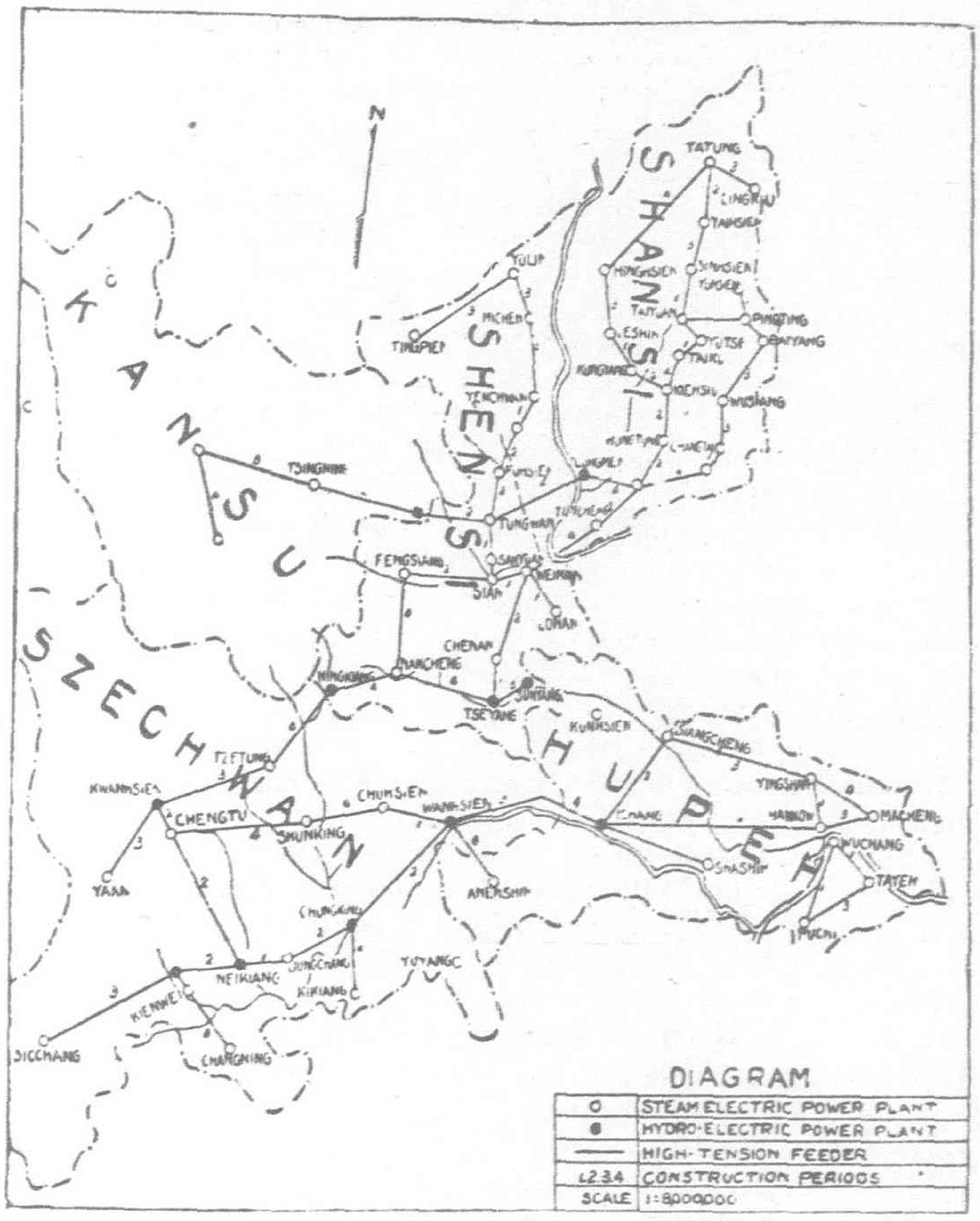
1. Motor boat machinery and its supplements
2. Alternate and direct current generators
3. Alternate and direct current machinery
4. Transformers
5. Oil switch and controllers

(*B*) *Accessories*

1. All kinds of electric meters
2. Small switches and supplements
3. Insulators
4. All kinds of wires and cables
5. Batteries
6. Household electric apparatus


KIANGSU
ANHWEI
CHEKIANG
SHANGHAI
NANKING
HANGCHOW
NINGPO
WENCHOW
DIAGRAM
TOWN
STEAM-ELECTRIC POWER PLANT
HYDRO-ELECTRIC POWER PLANT
HIGH-TENSION FEEDER
1.2.3.4 THE NUMBER OF WHICH INDICATES SUFFICIENTLY THE CONSTRUCTION PERIODS
SCALE 1:4000000

Projected Electric Power Plants in the Lower Yangtze Zone


N
KANSU
SHANSI
SHENSI
SZECHWAN
HUPEH
DIAGRAM
STEAM ELECTRIC POWER PLANT
HYDRO-ELECTRIC POWER PLANT
HIGH-TENSION FEEDER
1.2.3.4 CONSTRUCTION PERIODS
SCALE 1:8000000

Projected Electric Power Plants in the Upper Yangtze and Yellow River Zone

Electrification of China

Projected by the Chinese Government National Construction Commission

LOWER YANGTZE AREA

The electrification of the Lower Yangtze Area will be carried out in five periods of five years, according to the following schedule showing the capacity in kw. in the three provinces of the area and the length of the main high pressure transmission lines.

	Kiangsu	Chekiang	Anhwei	Capacity in each period	Estimate cost
The 1st period ..	110,000	5,600	25,000	191,000	$95,500,000
2nd ,, ..	160,000	18,000	53,000	291,000	145,500,000
3rd ,, ..	154,000	121,000	80,000	355,000	177,500,000
4th ,, ..	164,000	142,000	80,000	389,000	194,500,000
5th ,, ..	588,000	400,000	238,000	1,226,000	613,000,000
	76,200	15,700	4,000		
The present condition ..	173,500*				

*Shanghai Power Company

LENGTH OF MAIN TRANSMISSION LINES

	Kiangsu	Chekiang	Anhwei	Capacity in each period	Estimated expenditure
The 1st period ..	230	150	—	380	$ 4,560,000
2nd ,, ..	370	370	160	900	10,800,000
3rd ,, ..	260	290	230	780	9,360,000
4th ,, ..	120	140	100	360	4,320,000
Total ..	980	950	490	2,420	$29,040,000

The Southeast Division

Adjoining the Lower Yangtze Area, is what is designated the Southeast area, comprising the provinces of Kwangtung, Fukien and Kiangsi, with a total area of 1,723,000 sq. li and a population of 88,940,000. Agriculture and mining are the chief resources of the area, which, when developed, will create a great demand for power. The plan for the electrification of this area over the same period (five years for one period) is as follows:

ELECTRIFICATION OF THE SOUTHEAST AREA

(*a*) Capacity of Electricity to be generated in kw.

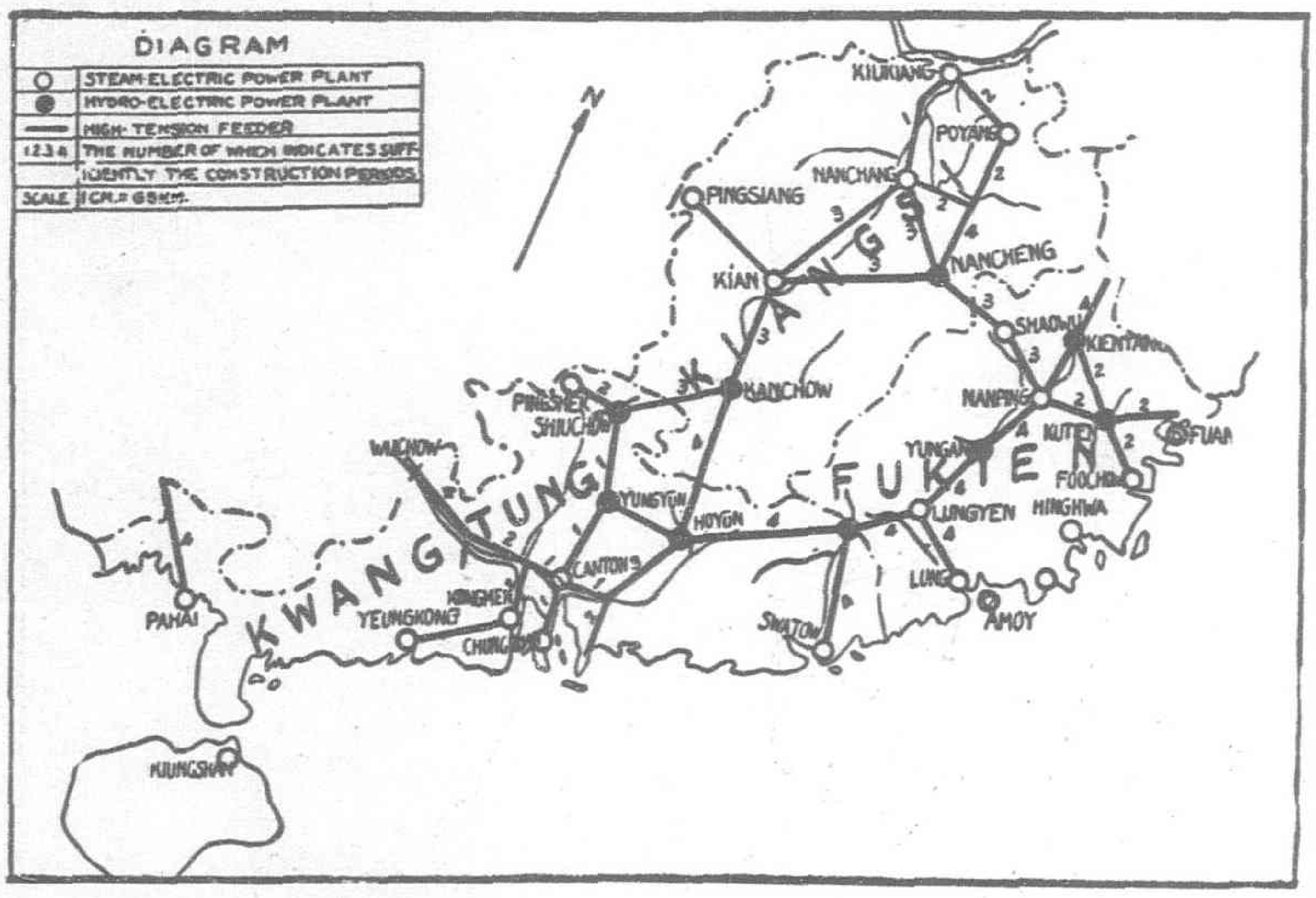
	Kwangtung	Fukien	Kiangsi	Total Capacity in each period	Estimated expenditure
1st period ..	25,800	5,800	6,130	37,730	$18,865,000
2nd ,, ..	47,400	15,000	10,770	73,170	36,585,000
3rd ,, ..	75,800	27,700	33,800	137,300	68,650,000
4th ,, ..	130,600	42,200	36,000	206,800	103,400,000
Total ..	279,600	90,700	86,700	455,000	$227,500,000

(*b*) Main Transmission Lines to be erected

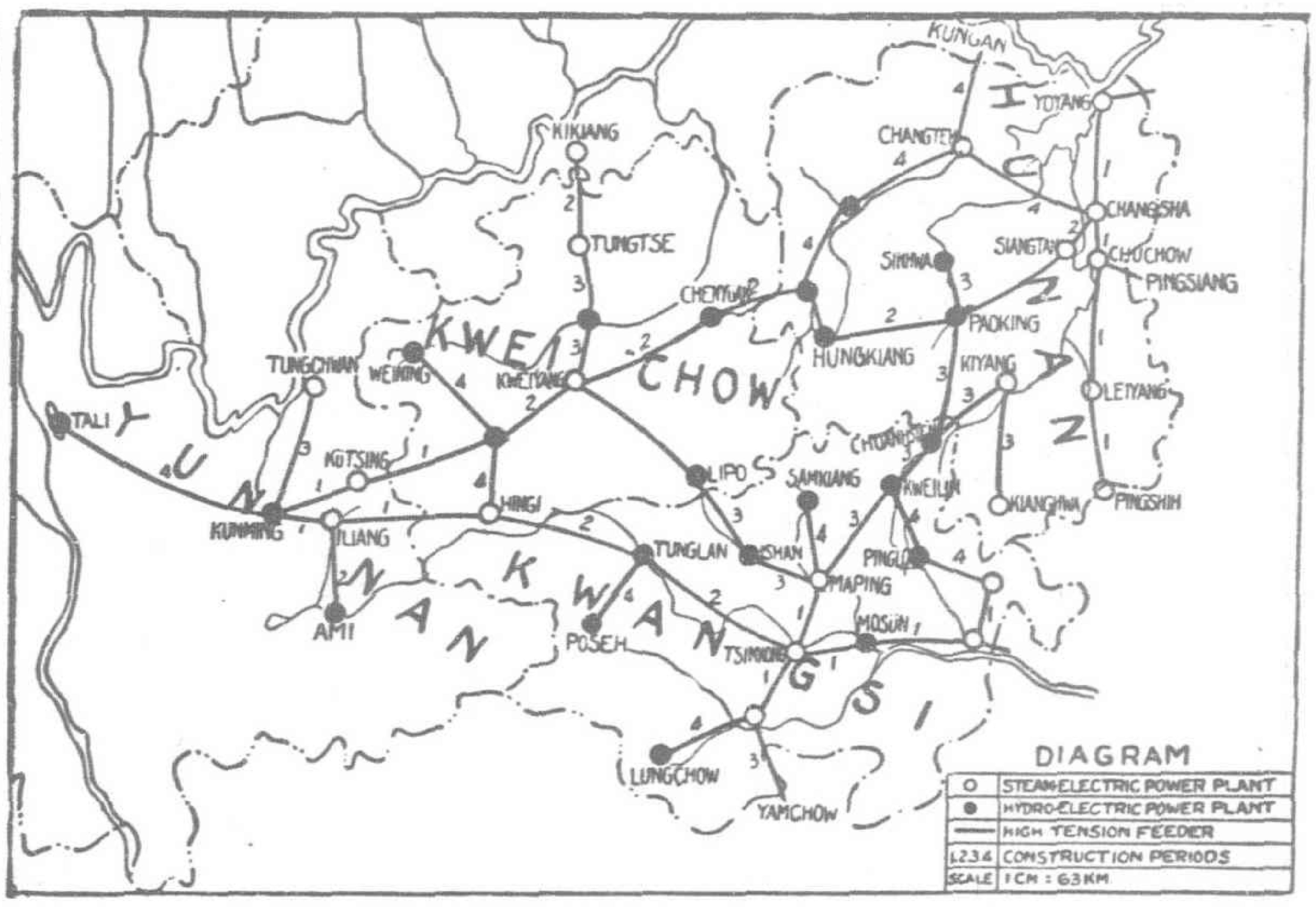
	Kwangtung	Fukien	Kiangsi	Total length in each period	Estimate of expenditure
1st period ..	380	—	100	580	$ 6,960,000
2nd ,, ..	320	240	180	740	8,880,000
3rd ,, ..	240	130	460	830	9,960,000
4th ,, ..	920	430	260	1,600	19,320,000
Total ..	1,960	800	100	3,760	$45,100,200

The Southwest Division

The Southwest Area includes Hunan, Kweichow, Kwangsi and Yunnan provinces. The project will be carried out in four periods with an ultimate capacity of generating 400,000 kw. and a total length of 6,920 km. of main transmission lines at an expense of $283,040,000.



Projected Electric Power Plants in the South-Eastern Provinces



Projected Electric Power Plants in the South-Western Provinces

Electrification of Southwest Area

(*a*) Capacity of Electricity to be generated in kw.

	Hunan	*Kwangsi*	*Yunnan*	*Kweichow*	*Total in each period*	*Estimated expenses*
1st period ..	40,000	20,000	15,000	5,000	80,000	$40,000,000
2nd ,, ..	35,000	35,000	5,000	30,000	105,000	52,500,000
3rd ,, ..	30,000	40,000	5,000	30,000	105,000	52,500,000
4th ,, ..	35,000	40,000	25,000	10,000	110,000	55,000,000
Total ..	140,000	135,000	50,000	75,000	400,000	$200,000,000

(*b*) Length of Main Transmission Lines to be erected in kilometers.

	Hunan	*Kwangsi*	*Yunnan*	*Kweichow*	*Total in each period*	*Estimated expenses*
1st period ..	490	580	720	200	1,690	$20,280,000
2nd ,, ..	580	400	160	610	1,750	21,000,000
3rd ,, ..	320	550	160	470	1,500	18,000,000
4th ,, ..	620	560	520	280	1,980	23,760,000
Total ..	2,010	2,090	1,260	1,560	6,920	$83,040,000

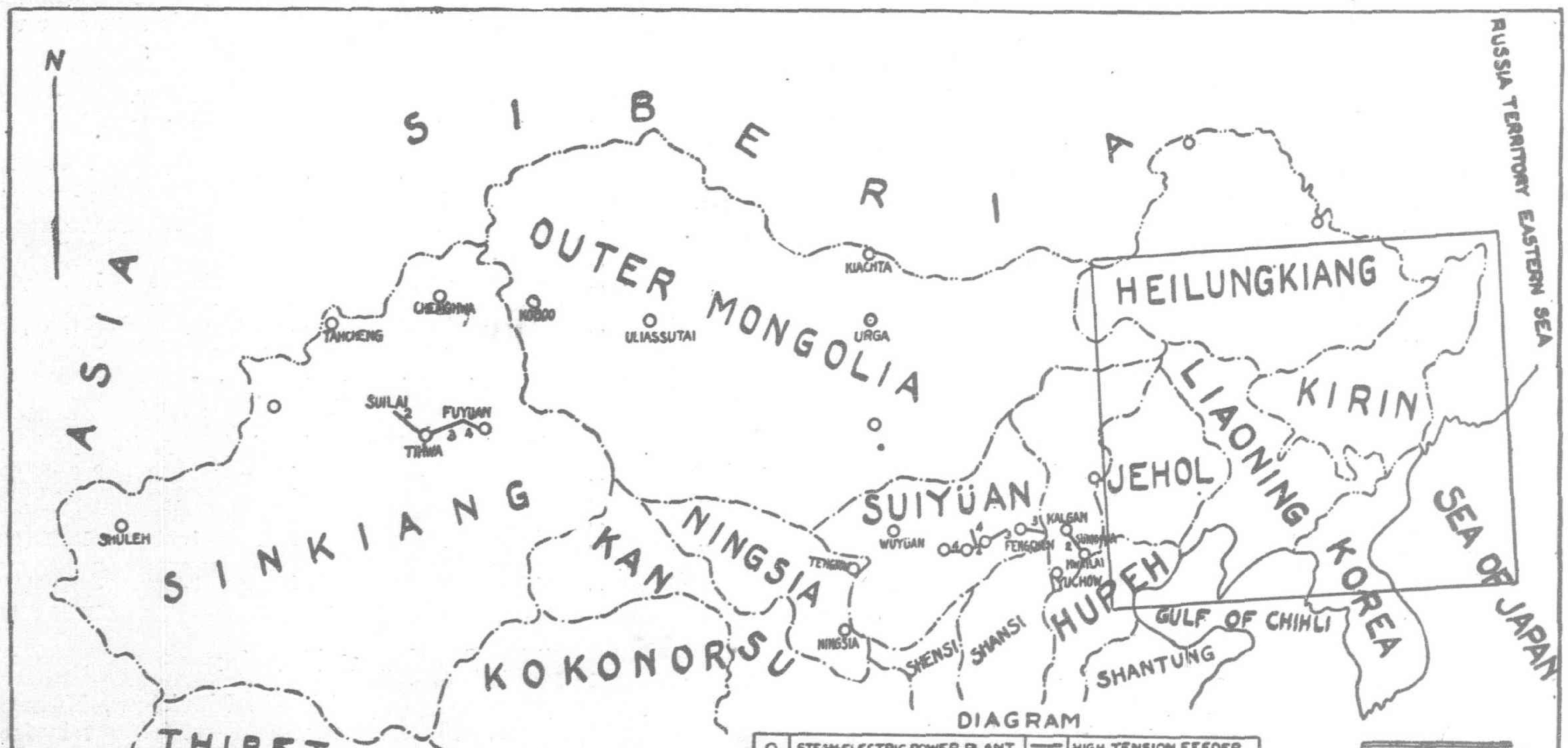
The Western Division

The next area to be electrified is the upper reaches of the Yangtze and Huang Ho. This area includes Tsinghai, Kansu, Szechuan, Hupeh, Shensi and Shansi provinces. This will give a total of 1,053,000 kw. of electricity when the whole project is completed and a length of 7,640 km. of main transmission wires. The tötal expenditure is estimated at $673,500,000.

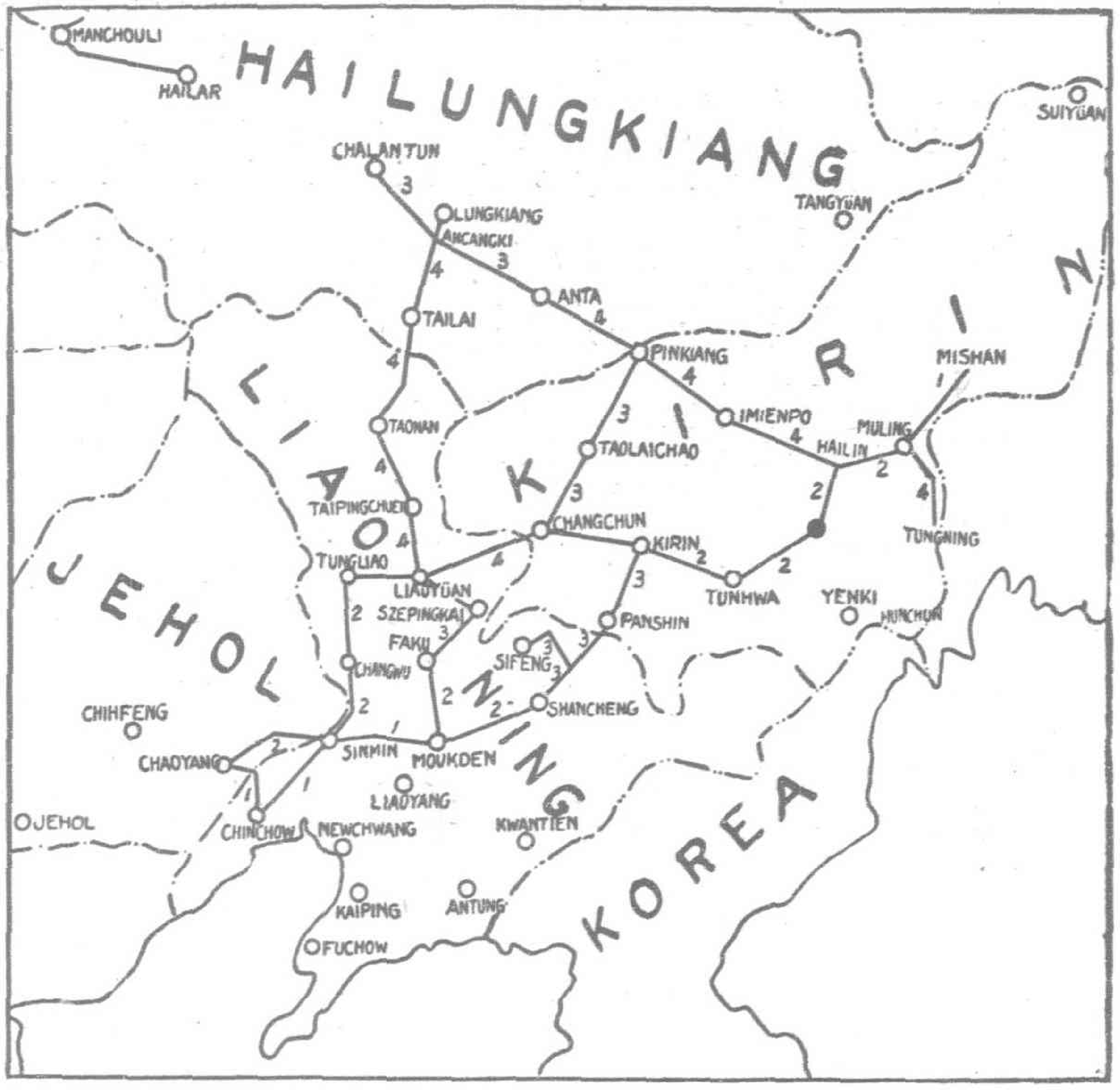
The Electrification of Upper Reaches of Yangtze and Huang Ho

(*a*) Capacity of Electricity to be generated

	Tsinghai	*Kansu*	*Szechuan*	*Hupeh*	*Shensi*	*Shansi*	*Total for each period*	*Estimated cost*
1st period	2,000	10,000	30,000	70,000	11,000	30,000	153,000	$83,000,000
2nd	2,000	10,000	60,000	80,000	23,000	45,000	220,000	119,600,000
3rd ,,	3,000	15,000	80,000	100,000	32,000	60,000	290,000	157,900,000
4th ,,	5,000	25,000	100,000	120,000	40,000	100,000	390,000	213,000,000
Total	12,000	60,000	270,000	370,000	106,000	235,000	1,053,000	573,500,000



Projected Electric Power Plants in the Northern Provinces



Projected Scheme for Manchurian Provinces

(*b*) Length of Main Transmission Lines to be erected in km.

	Tsinghai	*Kansu*	*Szechuan*	*Hupeh*	*Shensi*	*Shansi*	*Total in each period*	*Estimated cost*
1st period	—	—	170	460	300	390	1,320	$17,100,000
2nd ,,	—	170	420	520	490	460	2,060	27,100,000
3rd ,,	—	170	660	460	510	450	2,250	29,600,000
4th ,,	—	120	380	300	630	580	2,010	26,500,000
Total	—	460	1,630	1,740	1,930	1,880	7,640	100,300,000

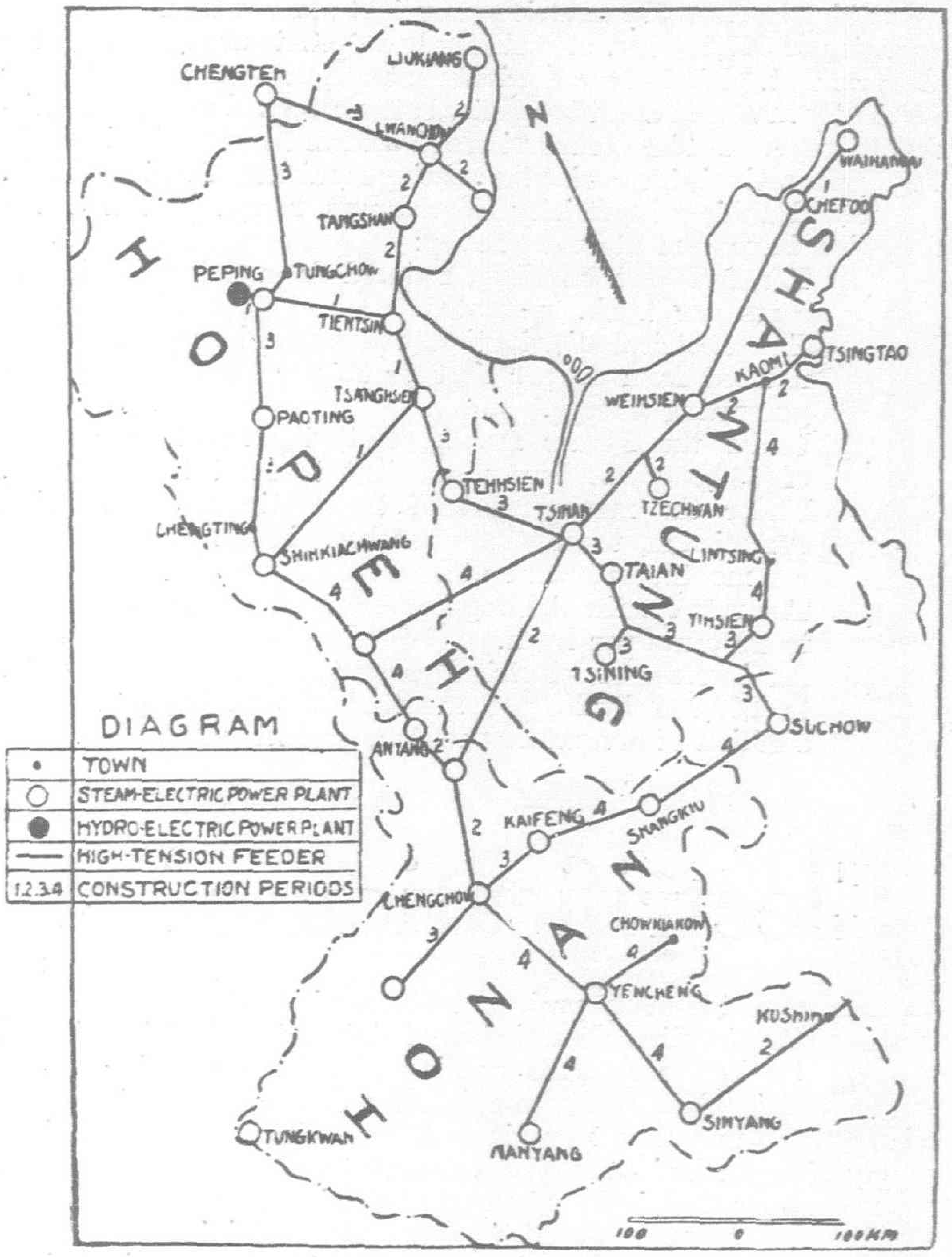
Lower Huang Ho Area

The Lower Huang Ho Area includes Hopei, Honan and Shantung. The total cost will be $572,880,000. The total capacity of electricity to be generated will be 1,038,000 kw. and the length, of main transmission will be 4,490 km.

THE ELECTRIFICATION OF HUANG HO AREA

(*a*) Capacity of Electricity to be generated in kw.

		Hopei	*Shantung*	*Honan*	*Total in each period*	*Estimated cost*
1st period	..	38,000	25,000	6,000	69,000	$34,500,000
2nd ,,	..	80,000	51,000	28,000	159,000	79,500,000
3rd ,,	..	150,000	87,000	63,000	300,000	150,000,000
4th ,,	..	265,000	136,000	109,000	510,000	255,000,000
Total	..	533,000	299,000	206,000	1,038,000	519,000,000



Projected Electric Power Plants in the Lower Yellow River Zone

(*b*) Length of Main Transmission Lines to be erected in km.

		Hopei	*Shantung*	*Honan*	*Total in each period*	*Estimated cost*
1st period	..	410	270	—	680	$ 8,160,000
2nd ,,	..	320	550	350	1,220	14,640,000
3rd ,,	..	650	400	200	1,250	15,000,000
4th ,,	..	260	380	700	1,340	16,080,000
Total	..	1,640	1,600	1,250	4,490	$53,880,000

Northern Area

The Northern Area will include the following provinces: Kirin, Liaoning, Heilungkiang, Jehol, Charhar, Suiyuen, Ninhsia, Sinkiang and Mongolia. Total cost estimated, $505,920,000; total capacity of electricity to be generated, 900,000 kw.; total length of transmission lines to be erected, 4,660 km.

(*a*) Electricity to be generated in kw.

	Liaoning	*Kirin*	*Heilung-kiang*	*Jehol*	*Chahar*	*Siyuen*	*Linhsia*	*Mongolia*	*Sinkiang*	*Total in each period*	*Estimated cost*
1st Period	40,000	15,000	12,500	5,000	—	—	—	800	3,000	76,300	$38,150,000
2nd ,, ...	80,000	37,500	20,000	12,500	10,000	10,000	—	1,900	3,400	175,300	87,650,000
3rd ,, ...	120,000	57,500	27,500	17,500	15,000	25,000	5,000	3,000	6,700	277,200	138,600,000
4th ,, ...	150,000	80,000	40,000	25,000	25,000	35,000	5,000	4,300	6,900	371,200	185,600,000
Total	390,000	190,000	100,000	60,000	50,000	70,000	10,000	10,000	20,000	900,000	$450,000.000

(*b*) Main Transmission Lines to be erected in km.

	Liaoning	*Kirin*	*Heilung-kiang*	*Jehol*	*Chahar*	*Siyuen*	*Linhsia*	*Mongolia*	*Sinkiang*	*Total in each period*	*Estimated cost*
1st Period	340	260	—	—	—	—	—	—	—	600	$ 7,200,000
2nd ,, ...	460	400	140	140	100	—	—	—	130	1,370	16,440,000
3rd ,, ...	540	300	200	—	—	220	—	—	130	1,390	16,680,000
4th ,, ...	420	310	240	—	—	280	—	—	50	1,300	15,600,000
Total	1,760	1,270	580	140	100	500	—	—	310	4,660	$55,920,000

China has now 575 electric power light plants with an aggregate capacity of 527,240 kw. of which only 17 plants are owned by the Government. Most of these private enterprises are not properly nor efficiently managed and the public, both urban and rural, not satisfactorily served. The Commission of National Construction in April, 1928, were active in improving the existing conditions of various plants.

The Nanking Electricity Works was reorganized and the following improvements were made:

(*a*) The fuel cost has been reduced from 4.2 cents to 2.7 cents per kw.h. generated.

(*b*) The electrical distribution and other losses have been reduced from 60 per cent to 38 per cent of the total generating energy.

(*c*) Under the former management, the monthly revenue of $30,000 was barely sufficient to meet the expenses. Under the management of the National Construction Commission, the revenue has been increased to $90,000 per month, with a monthly expenditure of $40,000.

(*d*) The rate for the lighting has been reduced from 24 cents to 22 cents per kw.h.

(*e*) An increase of electrical output from 350,000 kw.h. to 860,000 kw.h. per month has been effected by an addition of several new units aggregating 3,200 kw.

A number of improvements were made also in the Tsishuyen Electricity Works as part of the general scheme of the electrification of the Lower Yangtze Area.

(*a*) The monthly revenue has been increased from $42,000 to $80,000 with only a slight increase in the monthly expenditure.

(*b*) In Wusih the rate for lighting has been reduced from 26 cents to 16.2 cents and in Changchow from 22 cents to 18 cents. The rate for power has been considerably reduced also.

(*c*) The fuel cost has been reduced from 1.83 cents to 1.46 cents per kw.h. generated.

(*d*) The sale of electricity has been increased from 1,200,000 kw.h. to 1,600,000 kw.h. per month.

(*e*) Besides lighting, this plant supplies power to more than 100 factories and also for the irrigation of more than four thousand *mows* of land.

As to the Hangchow Electricity Works, a semi-official company with a total capital of $1,985,900 ($435,000 appropriated from the Chekiang provincial government treasury). Considerable reduction of cost has been realized as in the other plants described above.

Electrification of the Lower Yangtze Area

AMONG the many projects to be carried out by the National Construction Commission of China, the electrification of the Lower Yangtze area is perhaps the most important. This plan, when completed, will enable Chekiang and Kiangsu, the two richest provinces of China to have an unlimited supply of power for industrial development and open up a tremendous market for electrical equipment of all kinds.

The report of the Commission for 1930, explaining the reasons why the Government has taken over control of public utility enterprises, says that it is now admitted in engineering circles that the sporadic construction of power plants and transmission lines by competing companies has been extremely wasteful. Each company or power plant had its spare or reserve generating units which were idle the greater part of the time. Each company because of its own needs, economy, or other selfish reasons, had its own systems of frequency and voltages.

A movement to establish systems of main transmission lines of standard frequency and voltages for the purpose of inter-connecting the principal generating stations throughout the country has already been in progress in the United States, Great Britain and other European countries. The outcome of this movement is centralized generation of electricity in a small number of large, economical stations, reducing waste, conserving useful energy, improving national economy, promoting and stimulating the manufacturing and agricultural industries of the country.

The National Construction Commission was formed for the sole purpose of rehabilitating the industries of the country. It recognized that electricity was, is, and will be, the life blood of all industries. It was impossible for the Commission to engage in every line of industry, but considered it a paramount necessity to supervise the development of electric power, throw overboard the mistakes of other countries and assume the responsibility to promote and regulate the supply of electricity and distribute it cheaply to every consumer of the country.

The lower Yangtze valley has the greatest supply of electricity in the country. The triangular area between Nanking, Shanghai and Hangchow is dotted with generating plants, only a few of which, however, are of importance, such as Wuhu, Nanking, Chinkiang, Tsishuyen, Soochow, Shanghai and Hangchow. The rest are all small units of 5 kw. capacities in most cases operated by oil engines. Oil is not produced in China and has to be imported, which in the sense of national economy is undesirable.

The National Construction Commission has therefore proposed a scheme to electrify the above area by a network of transmission lines connecting a number of Government operated generating stations and a number of selected private stations of appropriate capacities, with switching stations at proper points to supply electric current to communities which depend on small oil engine units and to those communities which were not yet supplied.

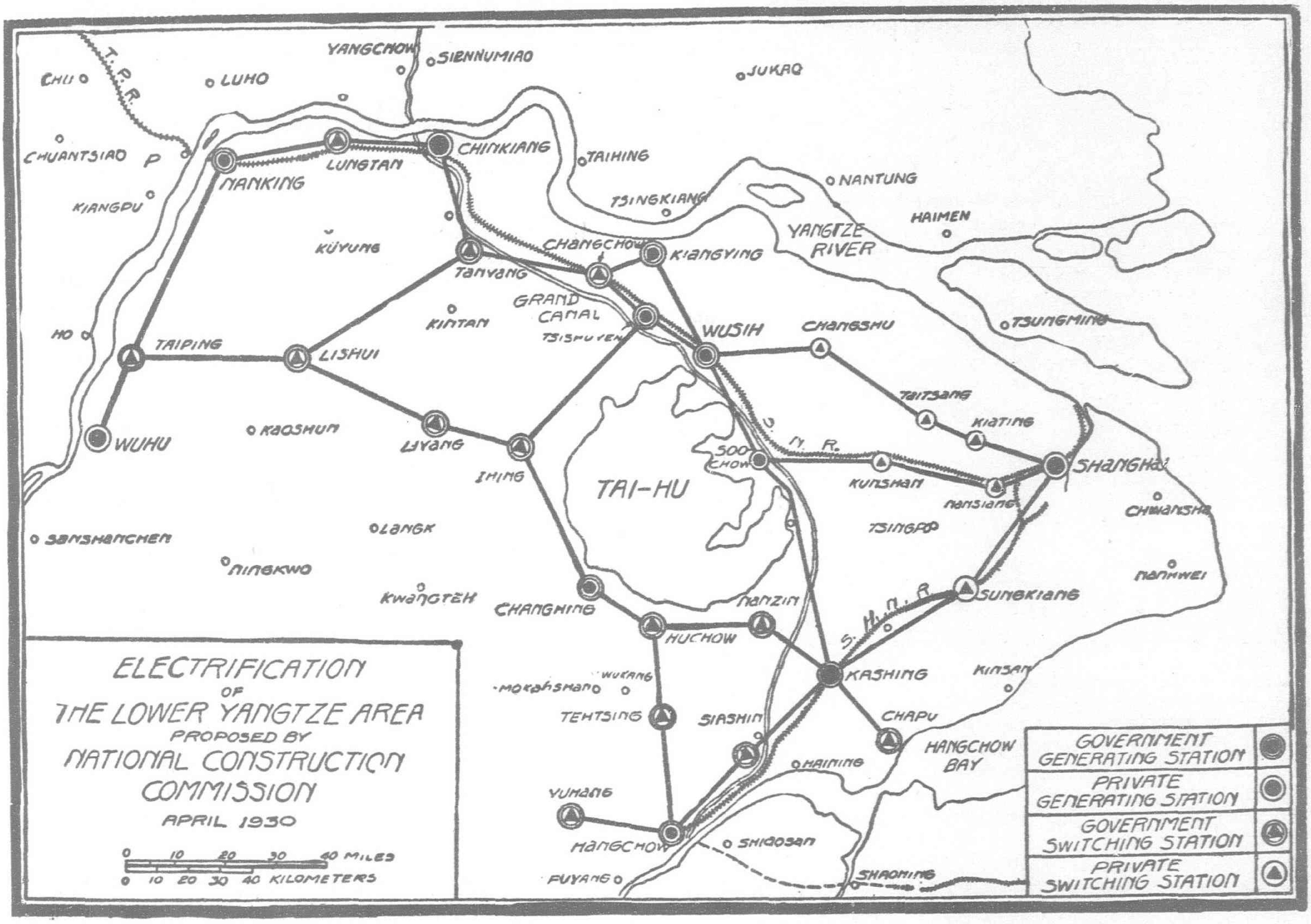
The Commission is at present operating a generating station at Nanking and one at Tsishuyen, supplying the cities of Wusih and Changchow. The Chekiang Electricity Bureau, a district function of this Commission, is operating one station at Hangchow and another at Yuhang. Three primary generating stations of 60,000 kw. ultimate capacity each, three secondary generating stations of 15,000 kw. ultimate capacity each, and four or more selected private stations having capacities from 3,000 to 40,000 kw. are to feed the proposed network. The primary stations are to be located at Nanking, Kiangyin and Hangchow; the secondary stations at Changshing, Wusih and Kashing; and the selected private stations at Wuhu, Chinkiang, Soochow and Shanghai. All these stations are either at or near the principal load centers and distant from each other from 60 to 80 miles.

The selected private stations will be required to co-operate with the Commission in matters of generating economy, enlargement of plant capacity when necessary and exchange of current supply. All energy fed-in and fed-out of a station from and to another station shall be properly metered, and monthly balances cleared and paid at a contract price.

The small stations not selected shall be required to contract for a wholesale supply of current from the network, where they can buy power cheaper than they can generate their own supply and to retail it at a regulated price. Although this law has not yet been ratified by the Legislative Yuan, it is expected to be placed in force in the near future.

The proposed network as shown in the accompanying map undoubtedly will be beneficial to the consumers and also profitable to the electrical undertakers, as many important industries flourish along the two railways—the Nanking-Shanghai Railway and the Shanghai-Hangchow-Ningpo Railway—and silk is produced everywhere within this area. Irrigation by means of electricity has been carried out with success in the past few years by the Tsishuyen Station, and farmers further away from the existing supply, have begged in vain for this boon. Without such a network the needs of the people, both urban and rural, cannot be satisfactorily met. If we assign an area of 30 miles radius to be served by every generating or switching station, the network as proposed will be able to supply practically every community in the area, although the generating stations are few in number.

The system of the network will be three phase 50 cycles as, with few exceptions, the 50 cycles system is already adopted overwhelmingly in China. The system adopted throughout Europe, with the exception of Italy, are uniformly 50 cycles as reported by the Central Electricity Board of Great Britain.



Although the tendency in other lands is less to use high voltages such as 110,000 ; 132,000 ; 220,000 and possibly 380,000 volts, the conditions in China do not warrant such high voltage for the present. As the generating stations proposed for the network are from 60 to 80 miles apart, we propose to use 66,000 volts for all the transmission lines. This voltage has been adopted very extensively in America and Europe for secondary transmissions and there is a tendency in the former country to make it standard. In the future, when conditions warrant, we shall use 110,000, or a higher voltage for the main lines and still keep 66,000 volts for the secondary lines.

The Government Radio and Electric Works in Shanghai was handed over to the Commission by the former Military Council in November, 1928, and reorganized into the present Electrical Manufacturing Works in July 1929. Besides producing radio transmitters and receiving sets, the works is preparing to manufacture various kinds of standard electrical machinery and supplies for the power industry. A new plant has been built on the south bund of Whangpoo River at Shanghai and a large scale production will be started early in 1931.

In the public interest and for the advance of national economy all private electrical enterprises should be properly regulated and developed as integral units of the National Systems. With this in view, this Commission has undertaken to investigate and improve all the existing plants in the country and to draft laws and standardization rules pertaining to the power industry. The following is a list of existing electric undertakings to be connected to the general system for the electrification of Lower Yangtze Area :—

List of Existing Electric Undertakings to be Connected to the System

1.—HANGCHOW-YUHANG LINE

Puchao Electric Light Co., Yuhang	170 kw.
Liusha Electric Co., Liusha	10
Sienyang Electric Co., Pingyao	50
	230 kw.

2.—HANGCHOW-KASHING LINE

Hangchow Electric Works, Hangchow	7,000 kw.
Joesze Electric Co., Joesze	15
Shingkee Electric Co., Lingpoing	30
Kashing Electric Co., Kashing	250
Changan Electric Co., Changan...	25
Haining Electric Co., Haining	50
Hsiachiao Chang Ta Electric Light Co.	10
Yehzuk Electric Co., Yehsuk	180
Yuenwha Electric Co., Yuenwha	25
Haiyen Electric Co., Haiyen	20
Puming Electric Works, Tutien	10
Yaoming Electric Co., Wongtien	20
Sungtang Electric Co., Sungtang	17
Singming Electric Co., Singwong	20
Mingwha Electric Co., Pinghu	60
Chapu Electric Co., Chapu	40
Puyih Electric Light Co., Shemen	15
Pulee Electric Light Co., ...	15
Zaikee Electric Light Co., Sinsze	40
Yungming Electric Co., Chungteh	32
Kungming Electric Works, Puyuan	20
	7,894 kw.

3.—HANGCHOW-WUSHING LINE

Singming Electric Co., Tangtsi	70 kw.
Tehtsing Electric Co., Tehtsing...	46
Yuanta Rice Mill & Electric Light Works	10
Tangchi Electric Works, Tangchi	9
Sanpeh Electric Co., Sanpeh	17
Mingwha Electric Light Works, Linghu	40
Weiho Rice Mill & Electric Works, Wooho	22
	214 kw.

4.—KASHING-WUSHING LINE

Tsungsing Electric Co., Singzan	35 kw.
Wutsung Electric Co., Wutsung	75
Zingtsung Electric Light Co., Naning	200
Songling Electric Light Co., Songzing	36
	346 kw.

5.—KASHING-SHANGHAI LINE

Chiming Electric Light Co., Tienningtsong	5 kw.
Changyao Electric Co., Kasai	67½
Fengchin Electric Co., Fengchin	37½
Mingsing Electric Works, Singta	16½
Tsongming Electric Light Co., Tsonglientang	15
Tsuchin Electric Light Co., Tsuchin	40
Mingwha Electric Light Co., Tiuhong	16.7
Tsingshing Electric Light Works, Changyen	26
Singfu Electric Light Works, Luysha	8
Puyih Electric Light Works, Sitan	30
Yulee Electric Light Co., Tatsong	6
Singming Electric Light Co., Kanyao	16
Tungsung Electric Light Co., Yangmiao	5
Sungkiang Electric Works, Sungkiang	263
Moushingchang Electric Light Works, Yehsia	15
Foongzung Rice Mill & Electric Light Works, Tingling	10
Hoshing Electric Light Works, Tsonghong	14
Lihung Electric Co., Nanchiar	25
Zungheng Chang Electric Light Works, Tsingchangkiang	19
Yaochangwookee Electric Light Co., Tatuan	20
Changwha Electric Co., Singsan	20
Nansha Electric Light Co., Nanwai	40
Tsungzee Electric Light Works, Minhong	37.5
Leesun Rice Mill & Light Works, Singtsong	11
Hunlee Electric Works, Szechin	16
Taming Electric Light Co., Chowpu	60
Putung Electric Co., Potung	750
Chuanpei Electric Light Co., Zaochien	16
Tachuan Electric Light Co., Chuansha	20
Chupu Electric Light Co., Chukiako	90
Chinese Electric Co., Nantao, Shanghai	20,000
Sungyin Electric Light Co., Sungying	000
Tsungtai Rice Mill & Electric Light Works, Chian Wai Chiao	13
	21,728.7 kw.

6.—KASHING-SOOCHOW LINE

Fusing Electric Light Co., Shenzuk	220
Mingsing Co., Lili	20
Kungshing Electric Light Co., Pingwong	17
Tsenghu Electric Co., Wansia	15
Tapu Rice Mill & Electric Light Works, Peitsia	15
Singyih Electric Light Co., Tungli	100
Singming Rice Mill & Electric Light Works, Sintai	10
Mingsing Co., Kuanfo	25
	422 kw.

7.—SHANGHAI-SOOCHOW LINE

Tayayukee Electric Co., Tazan	30 kw.
Chapei Electric & Waterworks Co., Chapei	20,000
Ziangwha Electric Co., Chapei	575
Chengju Electric Co., Chenju	100
Nanziang Electric Light Co., Nanziang	40
Taikee Electric Co., Kunshan	75
Mingsing Rice Mill & Electric Works, Weiting	7.5
Singming Electric Co., Lozek	46
Yaiching Electric Light Co., Chenmo	20
Soochow Electric Co., Soochow	8, 150
	29,043.5 kw.

8.—SOOCHOW-WUSIH LINE

Tangkow Electric Co., Tankow	100
	100 kw.

9.—SHANGHAI-WUSIH LINE

Paoming Electric Co., Wusung	347 kw.
Shunkee Electric Light Co., Lootien	30
Yiuwha Electric Light Co., Liuho	30
Whashingyungkee Electric Light Works, Kating	40
Tatsong Electric Co., Tatsong	82
Shachi Electric Light Co., Shatow	30
Changming Electric & Rice Mill & Cotton Works, Tsitang	20
Yaopu Electric Light Co., Maili	20
Changshu Electric Works, Changshu	304
Yehfoong Rice Mill & Electric Works, Mochen	4
	907 kw.

10.—KIANGYIN-WUSIH LINE

Tsingyan Electric Light Co., Tsingyang	20
Whaming Electric Light Co., Kiangyin	162
	182 kw.

11.—WUSIH-CHANGCHOW LINE

Tsishuyen Electric Works, Tsishuyen	9,600
Kaiyuen Electric Light Co., Yunghong	100
Chining Electric Light Co., Lishe	10
Wutsing Electric Co., Changchow	2,125
	11,835 kw.

12.—KIANGYIN-CHANGCHOW LINE

Tie line only

13.—CHANGCHOW-TANYANG LINE

Peiming Electric Light Co., Pennu	20 kw.
Yuengming Electric Light Co., Luchin	10
Zaoming Electric Light Co., Tanyang	75
	105 kw.

14.—WUSIH-ISHING LINE

Wushing Electric Co., Wushing	1,100
Changming Electric Co., Changshin	50
Tsingsing Electric Light Co., Zanushan	25
Yaoih Electric Co., Ishing	85
Changtsu Electric Light Works, Changtsu	20
Puchao Electric Light Co., Szean	40
	1,320 kw.

15.—TSISHUYEN-ISHING LINE

Wuming Electric Co., Wuchiao	68 kw.
	68 kw.

16.—ISHING-LISHUI LINE

Tsinghung Electric Light Co., Liyang	160
Sanyangzungkee Electric Light Works, Tungpao	12
Mokeekaiming Electric Light Co., Lishua	15
	187 kw.

17.—LISHUI-TANGYANG LINE

Yeelee Electric Light Co., Kintan	100 kw.
	100 kw.

18.—TANYANG-NANKING LINE

Tachao Electric Co., Chinking	3,070 kw.
The Capital Electric Works, Nanking	4,540
	7,610 kw.

19.—NANKING-WUHU LINE

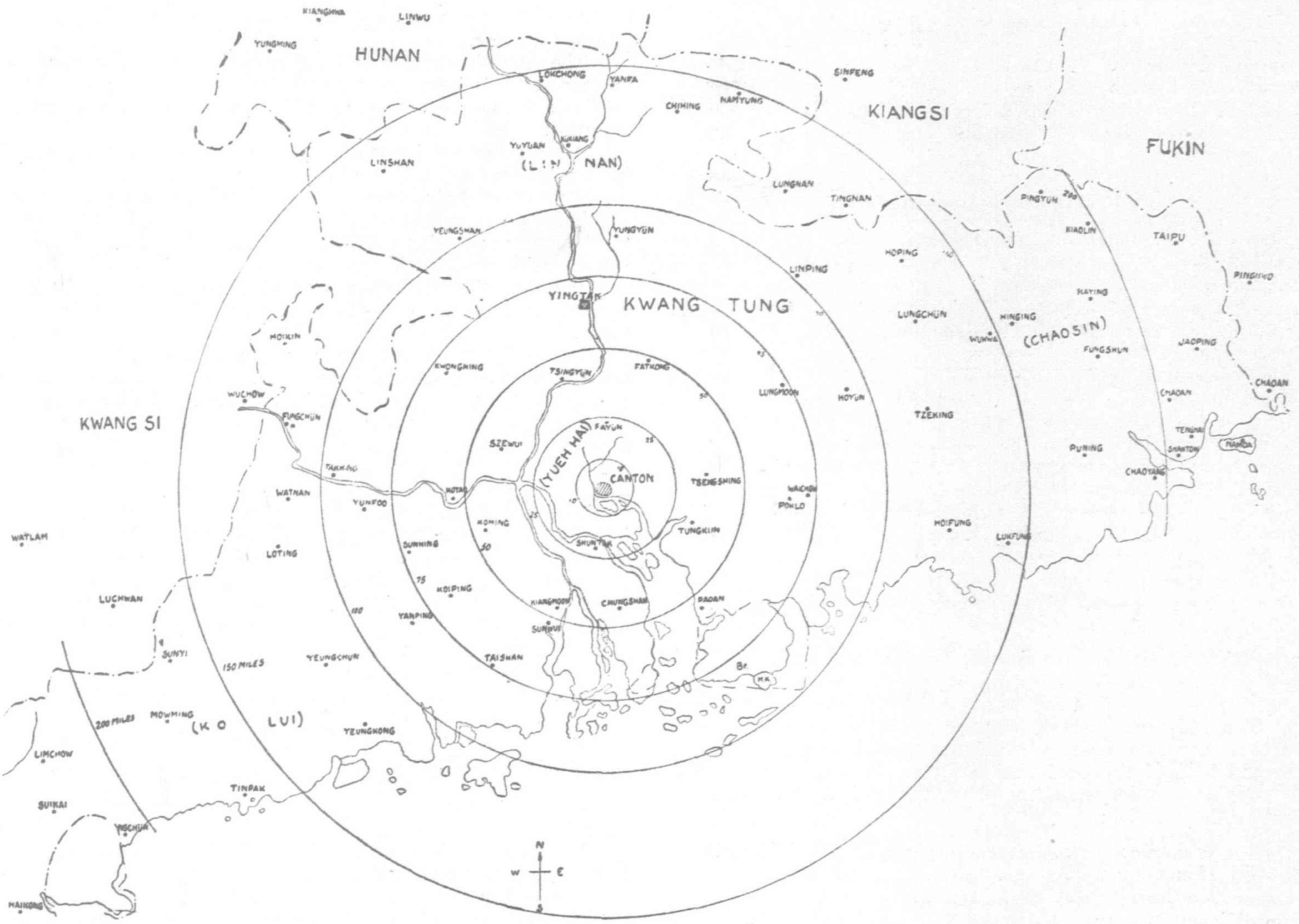
Tie line only.

Mingyuen Electric Co., Wuhu	2,456 kw.
Sinming Electric Light Co., Sansingwu	43
	2,499 kw.

20.—TAIPING-LISHUI LINE

Tie line only.

Sinwhazunkee Electric Light Works, Kaozun	12 kw.
	12 kw.



Kwangtung Province, China

Electricity Supply Scheme for the Province of Kwangtung, Portuguese Colony of Macao and the British Crown Colony of Hongkong

By *W. F. GILMAN*

An inter-connected transmission system for electricity supply to the cities and villages of Kwangtung Province including an inter-connection with Kowloon, Hongkong and Macao, is the logical and economical system for this area.

The Provinces of Kwangsi, Hunan, Kiangsi and Fukien border on Kwangtung. These provinces comprise an additional area for the future extension of the transmission system from Kwangtung.

Kwangtung has an area of 100,000 square miles with a population of 32,500,000. Hongkong, Kowloon, Macao, an area of 385 square miles, with a population of 1,232,000.

The geographical location of Kwangtung with relation to the provinces of South China is such that it's capital, Canton, on the Chukiang River, is the commercial and financial center.

The headquarters of Dr. Sun Yat Sen, the province was the first to endure the turmoil of the revolution, incident to the establishment of the Republic. It is one of the first provinces to progress in the recovery of its industrial life and stabilization of the governmental functions.

On a scale commensurate with its strategic location it will lead in the advance of the industrialization of South China. Particularly in the use of electricity for light and power.

Whampoa on the Chukiang River, ten miles south of Canton and seventy-five miles from Hongkong, is planned to be a trans-shipment port of sufficient magnitude to handle all imports and exports for South China. The railroads Canton-Kowloon, Kwangtung-Yueh Han and Canton-Shamsui, will be provided with facilities for direct trans-shipment of ocean freight.

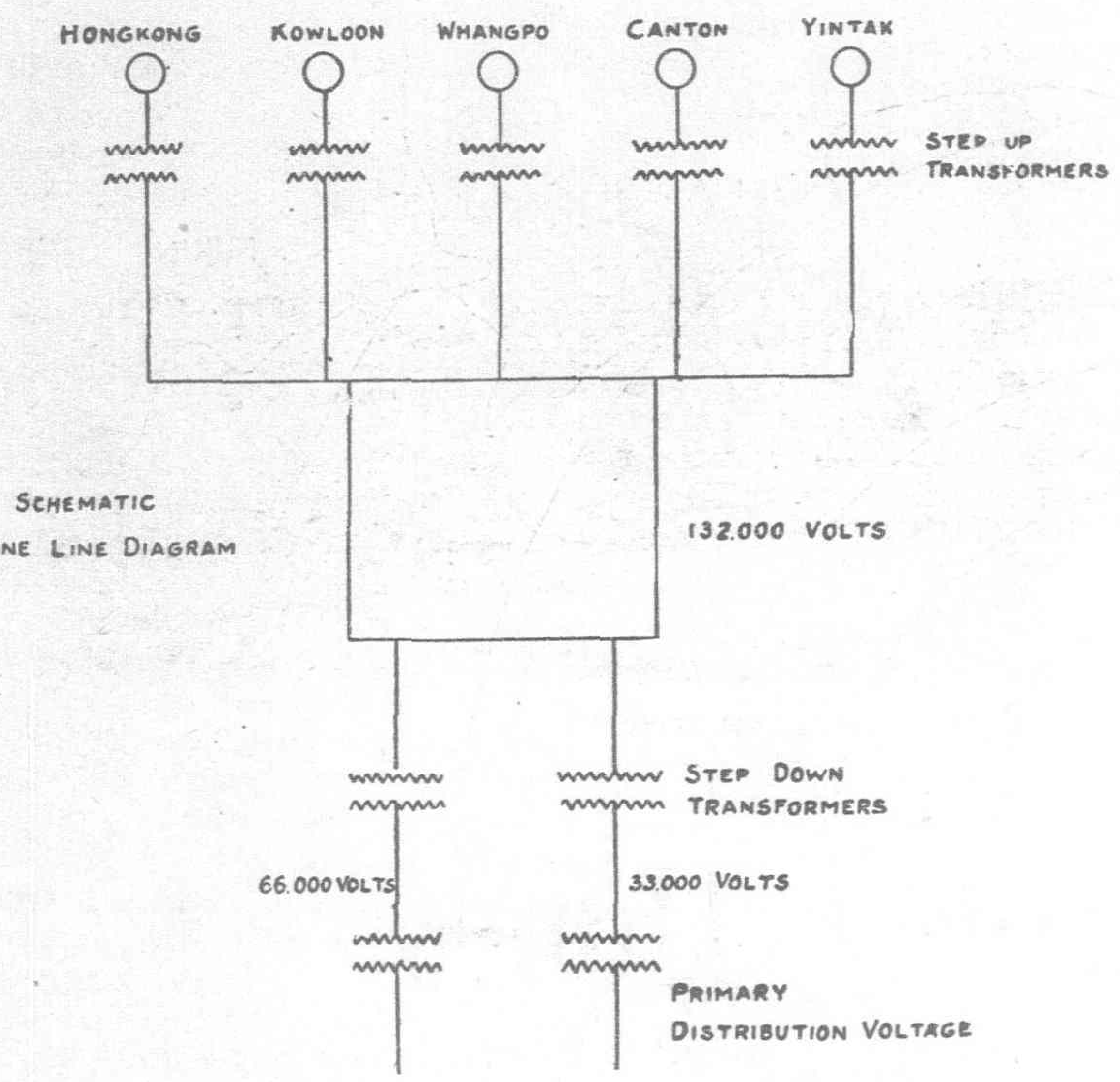
The uses for electricity supply include lighting of residences, factories, theaters, shops, restaurants and streets. Motor power for irrigation and drainage of farming lands, rice mills, factories, mining, rock crushers, cement mills, street railways and municipal water supply systems. Miscellaneous uses including cinemas, X-Ray apparatus, cooking, water heating, fans, laundry irons and refrigerators.

One and one-half million customers would be the users of this electricity supply.

The installed generating capacity within the area is 84,000 kilowatts, of which 50,000 would be available to supply the transmission system. Small uneconomical generating units account for 34,000 kilowatts. The operation of these generating units would be discontinued. The present demand load being supplied within the area is 60,000 kilowatts.

Available and prospective load within a ten year period is 140,000 kilowatts or a total of 200,000 kilowatts. Of this total 155,000 kilowatts is within an eighty-five mile radius of Whampoa.

Three primary generating plants to be located, respectively, at Whampoa, Kowloon and Ying Tak. Secondary generating plants, now in operation, would be Hongkong and Canton. The



generating plants, in several communities, now operating, to be held in reserve as standby operating plants, during the period of perfecting the operation and seasoning of the transmission systems.

The proposed hydro-generating plant at Ying Tak should be constructed to serve as a primary base load plant when the demand load of the transmission system is 100,000 kilowatts.

Capacity of the generating plants to supply a 200,000 kilowatt demand load to be:

Whampoa	..	steam turbines	120,000	kilowatts
Hongkong	..	,, ,,	25,000	,,
Kowloon	..	,, ,,	60,000	,,
Canton	..	,, ,,	15,000	,,
Ying Tak	..	Hydro	20,000	,,
A total of	..	.. ..	240,000	,,

A reserve capacity of 40,000 kilowatts is considered necessary.

Transmission lines erected on steel towers will interconnect the primary generating plants. Additional transmission lines erected within the Province of Kwangtung will form a Grid System

The distance from Whampoa of the additional transmission lines forming the Grid to be determined from a survey of the existing and prospective loads.

The completed Grid System will comprise between 285 and 300 miles of 3-phase 60 cycle lines operating at 132,000 volts.

Secondary transmission will comprise between 600 and 650 miles of 66,000 and/or 33,000 volts lines supplied from step-down transformer substations, at several load centers to the distribution systems, from the 132,000 Grid System.

The accompanying schematic diagram shows the system of transmission.

Distribution from the Grid System to the ultimate consumer is an important problem. Distribution systems should be constructed in accordance with predetermined standards.

Expenditures over the ten year period is estimated to total G. $40,000,000 for new generating plants and transmission lines. An additional expenditure of G. $25,000,000 will be required for the new distribution systems. The total investment should include the value of the existent operating generating plants and distribution systems, included in the scheme.

This expenditure should result in a profitable return on the capital invested. Adequate and satisfactory service to the territory. Reasonable and fair rates to the ultimate customer.

Minimum gross revenue may be based on a ratio of one dollar gross revenue per annum to five dollars of capital investment. Gross revenue would need to average eighteen dollars, per customer, per annum to provide this ratio.

Resultant economies of an inter-connecting transmission system as between the British Crown Colony of Hongkong, the Portuguese Colony of Macao and the Province of Kwangtung, out-weigh the political aspects.

The scheme suggests a ten year period of development as a minimum. A stable government, normal business conditions, availability and security of capital and adequate personnel is assumed.

All of these conditions do not exist at the moment. Security for capital investments for utility enterprises of this character in the Republic of China require a modification of the present laws.

Twenty-five per cent of the generator capacity proposed is at present in operation within the area. This is indicative of the future possibilities.

Practicability and economics of the scheme remain intact though the realization requires twice the time period or twenty years.

Expenditures for and construction of the generator plants and transmission lines may be made in such stages as the kilowatt demand load and general conditions dictate. The scheme should be envisaged as a whole. In the presentation of the ultimate scheme the various stages of development, excepting the first, are necessarily omitted. A definite procedure is a problem of available capital and its economic investment.

The first stage of the Grid system to be constructed should interconnect Canton, Kowloon and Hongkong. This would require the laying of a submarine cable between Kowloon and Canton. Frequency changer at Hongkong to change frequency from 50 to 60 cycles. A steel tower transmission line from Kowloon to Whampoa, designed for 132,000 volt operation, to be operated at 66,000 volts in the initial stage.

From Whampoa a 33,000 volt steel pole line carrying two circuits. Either circuit being of sufficient capacity for 10,000 kilowatts.

Three transformer substations will be required, one at Kowloon to step up the voltage to 132,000 and/or 66,000, one at Whampoa to step the voltage down from 132,000 and/or 66,000 to 33,000, and one at Canton to step down from 33,000 to the primary distribution voltage.

This construction would make available to Canton from Kowloon-Hongkong 10,000 kilowatts.

Expenditure of G.$1,350,000 is required.

Canton requires in addition to its present generating capacity, 5,000 kilowatts to supply the present demand load. And an additional 5,000 kilowatts one year later.

A steel tower line constructed adjacent to the Canton-Kowloon Railway, from Kowloon to Whampoa, will comprise the first link in the Grid system.

Electricity supply would be made available for power and lighting during the construction of the Whampoa generating plant and other constructive work in connection with the Whampoa port development.

On completion of the transmission system to Canton, a steel pole, 33,000 volt, single circuit, line should be constructed adjacent to the Canton-Shamshui Railway, from Canton to Fatshan, a distance of ten miles. This would permit of discontinuing the operation of the Fatshan plant. Add 2,000 kilowatts of load. An expenditure of G. $100,000 is required.

The first stage is economically justified on its own merits irrespective of the remainder of the scheme.

With the available generator capacity in the Kowloon and Hongkong plants ample to supply a 10,000 kilowatt load to Canton, the expenditure compares favorably with the expenditure required to install 10,000 kilowatts additional generating capacity in Canton.

The resultant economies in generating costs and additional distribution areas made available, from the transmission line operation, to the three companies concerned is sufficiently evident to require no comment.

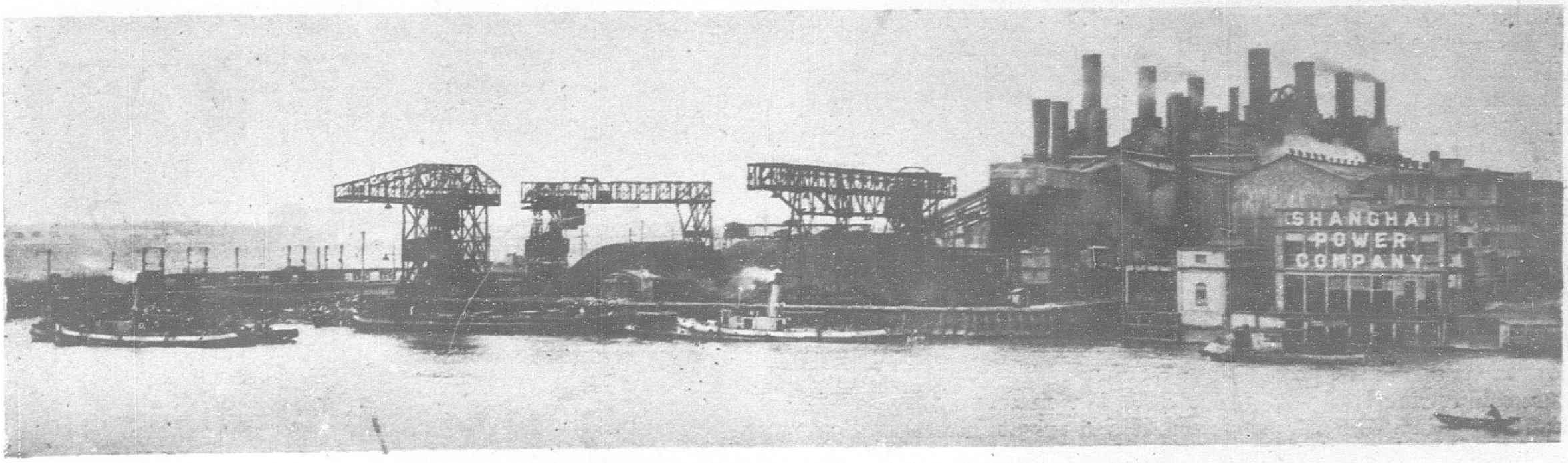
Explanatory Notes

Kilowatt capacity is taken at an 80 per cent power factor, of the kilovoltampere capacity of the generators.

The principal factors in determining the location of the primary steam generating are :—

1. Availability and direct handling of coal from steamship and/or railway car direct to bunkers or storage, *viz.*—cost of coal.
2. Ample water for condensing use.

(Continued on page 306).



Riverside Power Station—Southern end of site viewed from river

The Shanghai Power Houses

Including Some Interesting Details of Electricity Supply in Shanghai Brought Up-to-date

By C. S. TAYLOR, Vice-President and General Manager

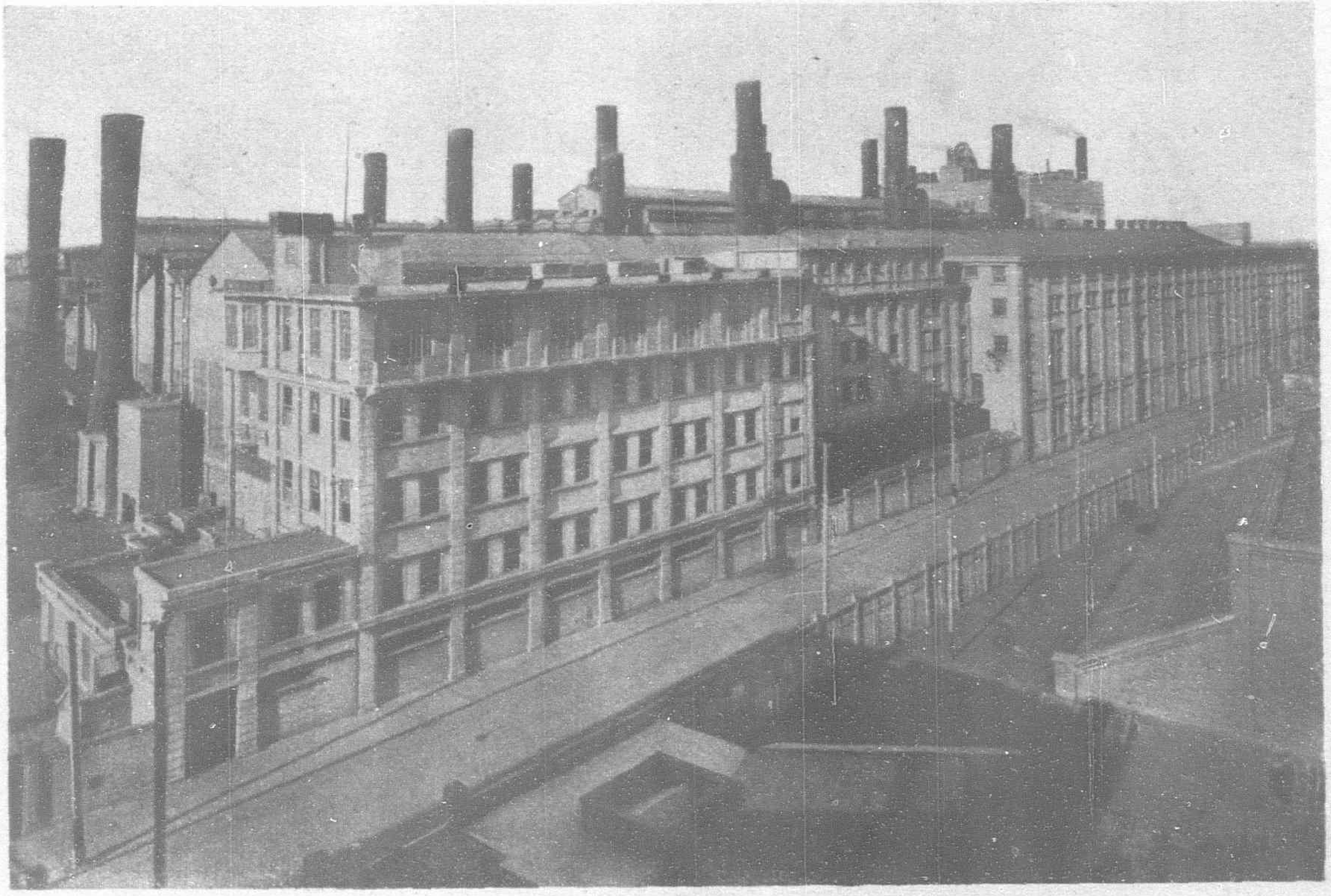
SHANGHAI, eighty years ago, was nothing but a cluster of houses on the bank of a relatively insignificant river with a hinterland of swamp and rice field ; now it is the sixth largest port in the world.

Situated on the Whangpoo River, twelve miles from the point where the latter joins the mighty Yangtze River, it commands the trade of Northern China. The enormous growth has been more pronounced in the last ten years, and the Foreign Settlements, namely—the International Settlement and the French Concession, with their huge commercial palaces, banks, schools, mills, shipyards, beautiful parks and public utilities, may be rightly described as model, credit for which is due solely to foreign enterprise and industry.

The International Settlement, to which this contribution refers, is a strip of land on the north bank of the Whangpoo River approximately nine miles in length, and varying in width from one to two miles. It is governed by a municipal council, which body is amenable to the foreign ratepayers of the Settlement, who in turn are protected by the agreement made between the Chinese Government and all the Treaty Powers subsequently to the throwing open of Shanghai to trade in the year 1841, under which a certain area was set aside for foreign residence and administration. The population of this area is approximately—foreigners 30,000, Chinese 810,000, and in the Chinese territory outside the Settlement boundary, known as Nantao and Chapei, there are over 1,000,000 Chinese.

It is an undeniable fact that the electricity undertaking in this Settlement has played a major part in its rapid development in that relatively cheap electric light and power has been available throughout a considerable proportion of this period. In regard to output it now outrivals Manchester or Glasgow. The administration and technical organization from the outset has been ninety-nine per cent British, headed for twenty-eight years by Mr. T. H. U. Aldridge, M.I.E.E., M.I.Mech.E., Fel.A.I.E.E., as Engineer-in-Chief and General Manager of the Municipal Electricity Department, latterly vice-president and general manager Shanghai Power Company, who upon his retirement in December, 1929, has been succeeded by Mr. C. S. Taylor, M.I.E.E., Mem.A.I.E.E., formerly deputy engineer-in-chief and manager of the undertaking during the period when it was the Municipal Electricity Department.

The history of electricity supply in Shanghai, as a Municipal Undertaking, dates from the year 1893. The maximum system load in 1913 was 8,100 kw., and it was in this year that the Riverside power station, with a capacity of 4,000 kw., was commissioned, the old station at Fearon Road, in the center of the Settlement, having a capacity of 6,400 kw. The demand began to increase rapidly about this time, as will be seen from a study of Fig. 8, showing the maximum system load for each year from 1910 to



Riverside Power Station—East side showing Offices and Switch House

1929, and the corresponding yearly load factor. As the result of negotiations early in 1929 between the Municipal Council and the American and Foreign Power Company, the electricity department was sold and transferred in August of the same year, and is now under the control of the Shanghai Power Company.

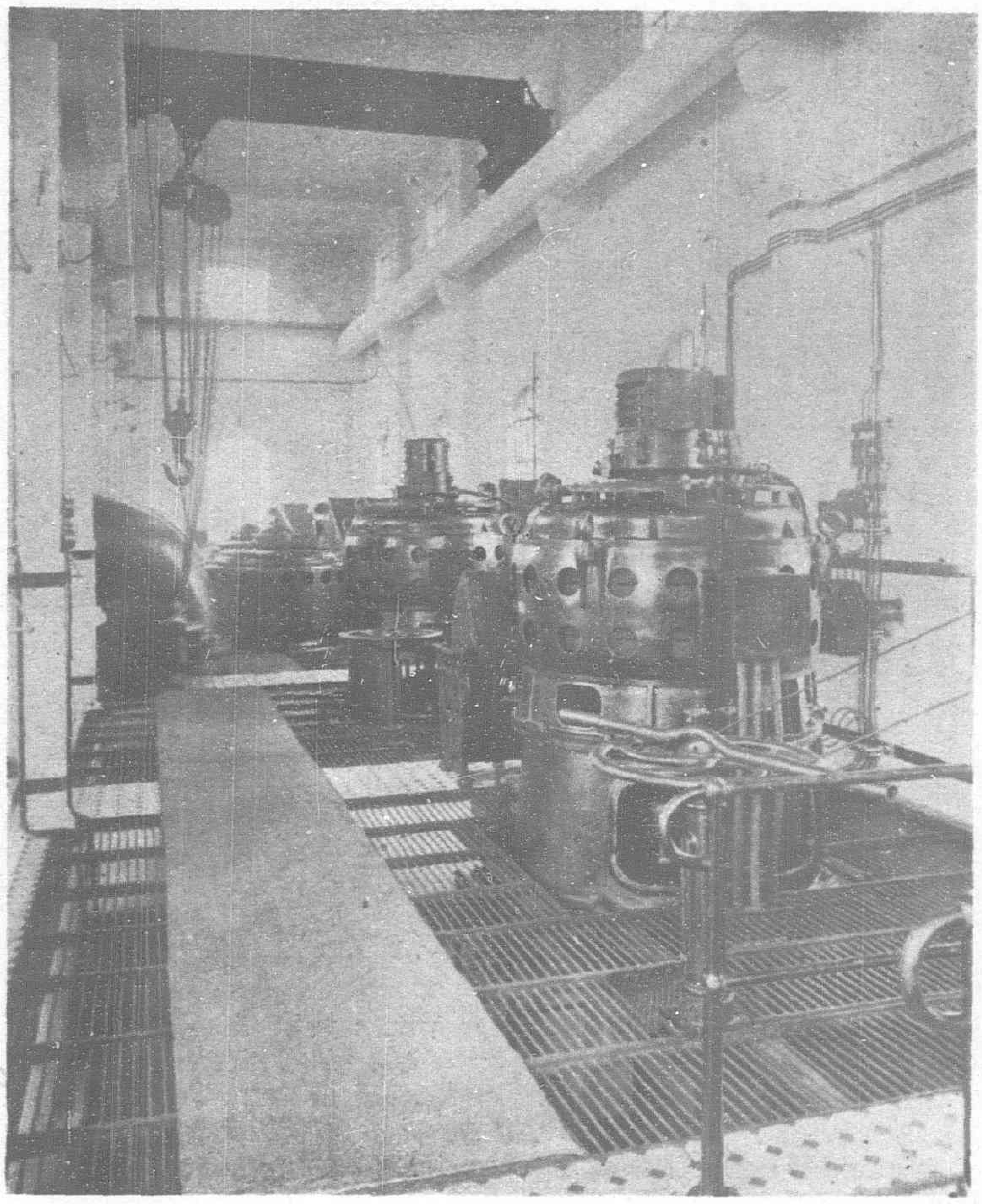
During the twelve months ending December 31, 1929, over 625 million units were generated, the maximum load being as a peak 112,100 kw., sustained for thirty minutes 111,500 kw., sustained for one hour 109,100 kw., the load factor based on the first-mentioned being 63.6 per cent. It is noteworthy that whilst the peak load for 1929 was 112,100 kw., the maximum recorded for January, 1930, is 116,600 kw. Load factors on ordinary working days are in the order of 80 per cent, and the chart on page 293 is given to show the shape of a typical daily load curve. The total kilowatt-hours sold during 1929 were 535,787,562 kw., made up as follows—Private lighting, 8.56 per cent; public and private street lighting, 0.58; heating and cooking, 1.79 per cent; power and traction, 89.07 per cent. Power supply is mainly to cotton and flour mills and the textile industry generally.

The power station site is on the north bank of the Whangpoo River, approximately five miles from, and east of, the Bund in Shanghai, and occupies an area of 17 acres. A general layout plan is shown on page 293 and the other photographs illustrating this article give a general idea as to the equipment of the station. To cater for future plant requirements an area of 15 acres of land, adjoining the existing site, has been recently acquired. Turbo-alternator plant installed now totals 161,000 kw., with boiler plant of 1,880,000 lb. per hour normal evaporation capacity, and 2,240,000 lb. per hour maximum evaporation and the extensions which have been made from time to time may be visualized by reference to the photographic view which is shown below on this page.

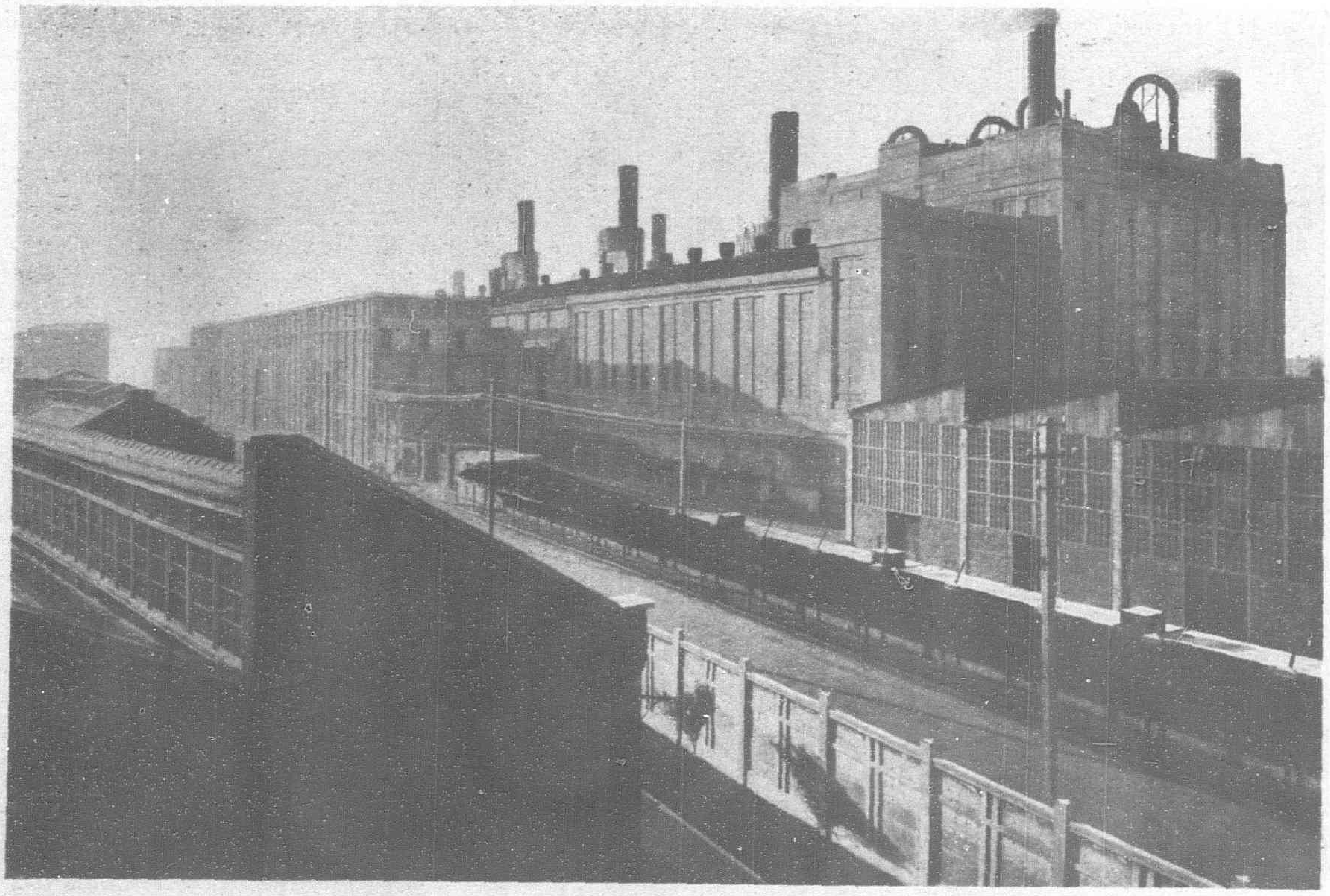
In considering the fourth extension it was decided to make marked departures from the operating conditions of the then existing plant, as will be seen from the tabular statement which appears at the top of the next column. This extension is regarded as a separate base-load station, and is operated as such.

Sections 1, 2 and 3 are therefore known as "A" station, and Section 4 as "B" station. Details of the turbo-alternator sets and boilers contained therein may be stated briefly thus:

	"B" Station, Extension.	*"A" Station, Existing Plant.*
Steam pressure at turbine ..	350 lb./sq. in.	195 lb./sq. in.
Steam temperature at turbine ..	700°	600°F.
Turbines	Twin cylinder, 3,000 r.p.m.	Single cylinder, 1,500 r.p.m.
Boilers	Pulverized fuel firing equipment	Chain grate and underfeed retort stoker equipment.
Feed heating	Turbine stage bleeding	Exhaust steam heating from turbo sets supplying auxiliaries.



Riverside Power Station—No. 2 Circulating Water Pump House

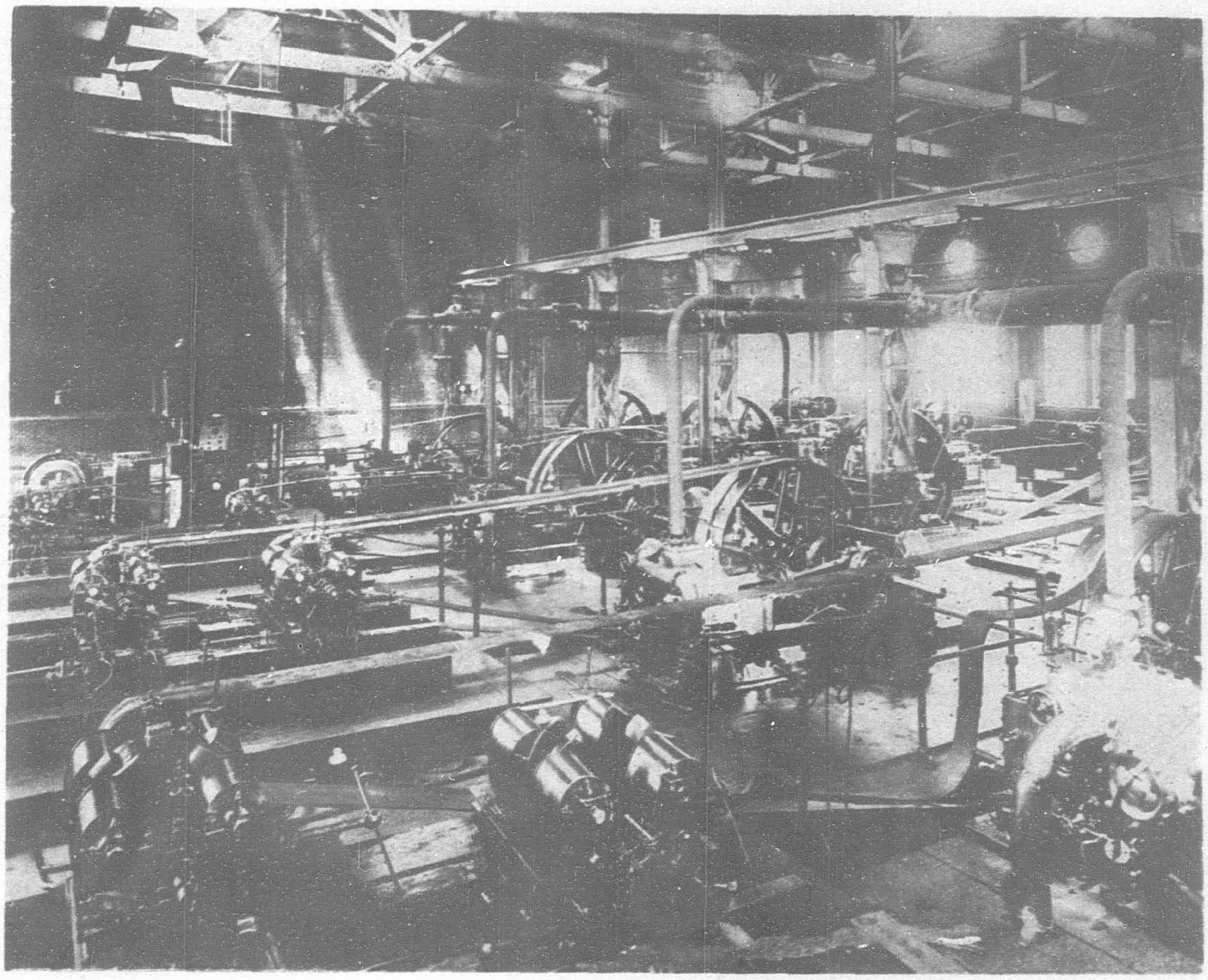


Riverside Power Station—North and East sides

Coal and Coal Handling.—Coal consumed during 1929 amounted to nearly 480,000 tons, averaging 1,315 tons per day. All coal is sea-borne from Northern China and Japan in shipments varying from 3,000 to 6,000 tons. This is purchased on a calorific basis, that is to say, at the time of placing contracts a standard is fixed in regard to proximate analysis, and bonus or penalties are awarded or imposed for any variation above or below the standard fixed. The vessels anchor in midstream opposite the station's foreshore and wharf, and delivery is taken into the company's steel lighters of 200 to 300 tons capacity. These lighters are handled between the ship and the wharf by the company's tugs. The coal is discharged from the lighters by three electrically-driven coal transporters of 40, 70 and 100 tons per hour capacity. Each transporter is equipped with an automatic weighing machine, and the coal is conveyed from the latter to storage bunkers by means of bucket and belt conveyors.

Storage space complete with mechanical storing, reclaiming and weighing equipment is provided, and gives the necessary margin between plant demand and deliveries. In addition to this a large stock, deposited and reclaimed by basket carrying coolies, is maintained, but this is regarded entirely as emergency coal for use in the event of strikes or other industrial trouble. The positions of these storage grounds relative to the station building are shown in the general layout plan.

Ash Handling Plant.—Ashes are deposited direct into ash tipping trucks, and these are shunted by electric locomotives to a wharf specially provided for this purpose, where they are discharged into hopper bottom steel lighters. Some of these ashes are purchased by contractors, and the remainder are dumped in deep water at a point near the mouth of the Yangtze River, fourteen miles distant from the station.



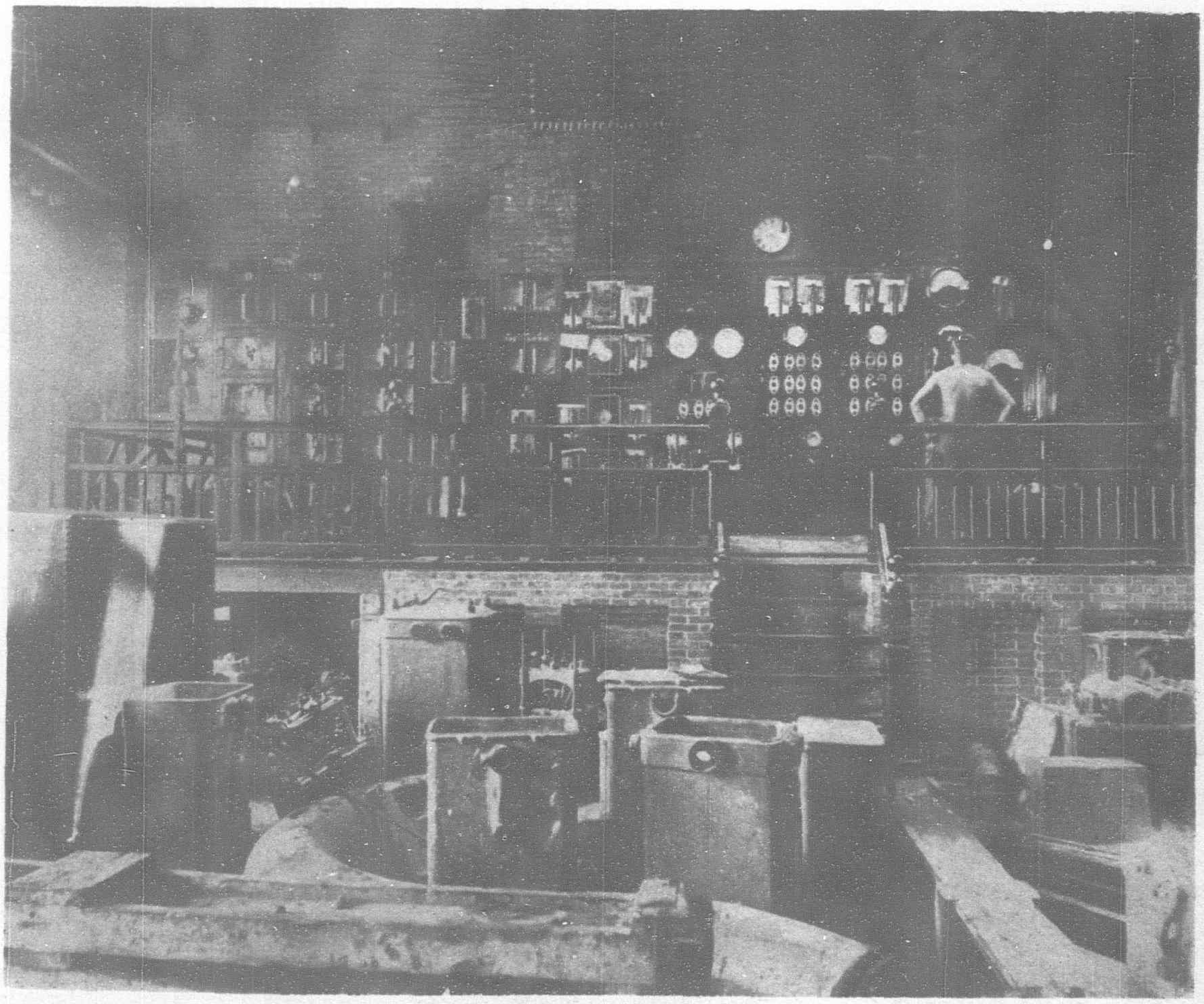
Former Fearon Road Generating Station—1900 View of Engine Room showing Brush Arc Light Generating Sets

Boiler Plant.—The boiler plant consists of four sections, namely—Nos. 1, 2, 3 and 4 boiler houses (Fig. 7). The boilers in the first three sections are coupled to a common range and operate normally at a steam pressure of 200 lb. per sq. in. and final steam temperature 600°F. As previously mentioned this part of the plant is known as "A" station; brief particulars in regard to capacities and types are as follows, from which it will be noted that all boilers in these three sections are equipped with mechanical stokers.

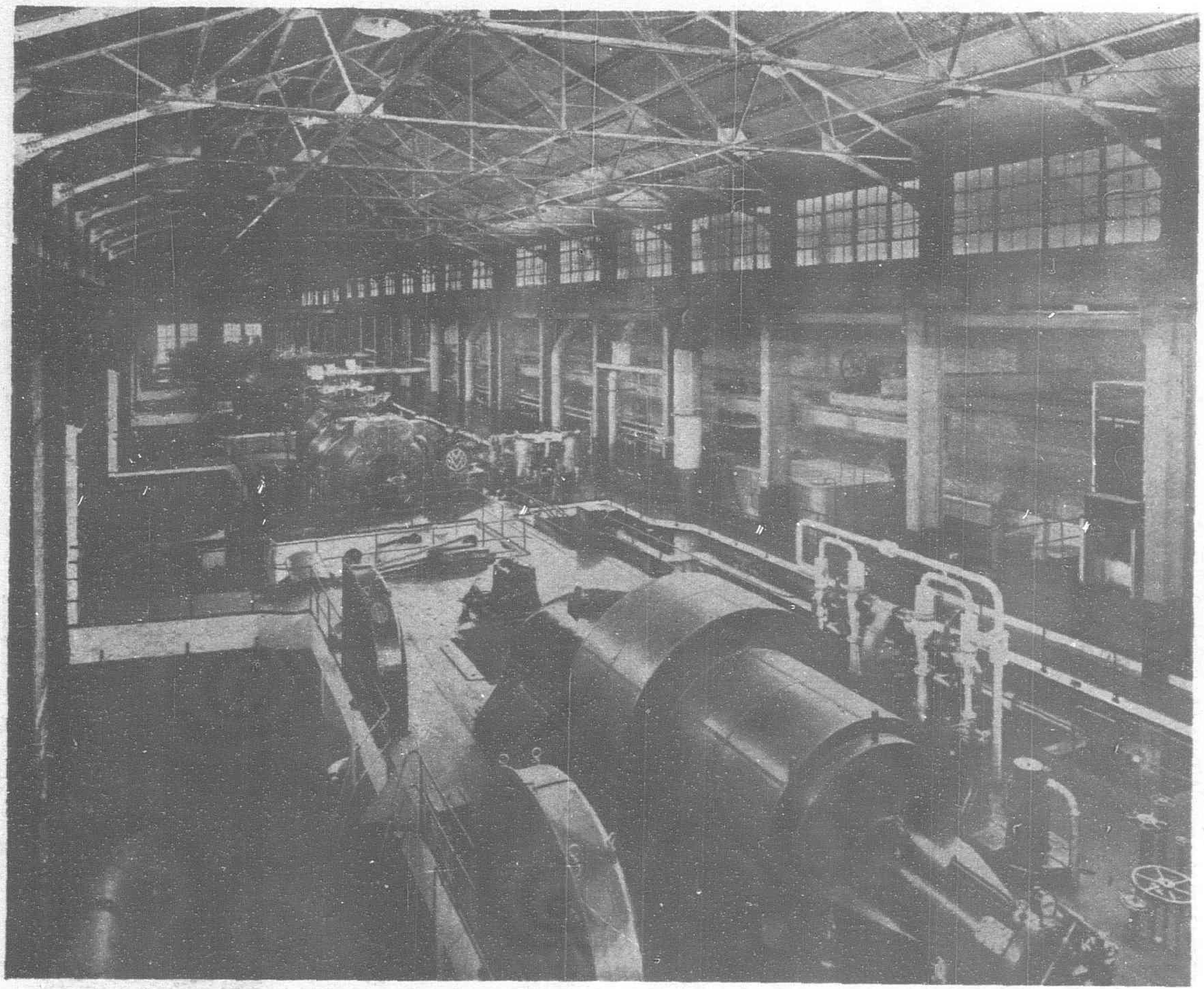
Section No. 1.—Four B. & W. land type, each 22,000 lb. per hour normal, and 25,000 lb. per hour maximum rating, equipped with Green's economizers and chain grate stokers, induced draught. Four B. & W. land type 28,000 lb. per hour normal, 35,000 lb. per hour maximum rating, equipped with Green's economizers and chain grate stokers, induced draught.

Section No. 2.—Eight B. & W. marine type, each 40,000 lb. per hour normal, 45,000 lb. per hour maximum rating; all equipped with superimposed steel economizers, chain grates being employed on six boilers and Riley retort stokers on the other two, balanced draught throughout.

Section No. 3.—Five B. & W. marine type and five Stirling tri-drum, each normal evaporation



Former Fearon Road Generating Station—1900 Switchboard



Riverside Power Station—1930. "A" Station Turbine Room, looking South. No. 11 machine in foreground

80,000 lb. per hour, maximum 90,000 lb. per hour, all equipped with superimposed steel tube economizers. Eight fitted with Riley retort stokers and two with B. & W. chain grate stokers. Howden-Ljungstrom preheaters have been added to eight of these boilers.

Section No. 4 (B. Station).—The boilers in the fourth section operate normally at a steam pressure of 375 lb. per sq. in., and final steam temperature 700° F. This part of the plant is known as "B" station. It supplies the requirements of the higher pressure turbo-alternator sets, and is connected to the 200 lb. per sq. in. steam range through reducing valves and a steam desuperheater. Brief particulars are as follows :—

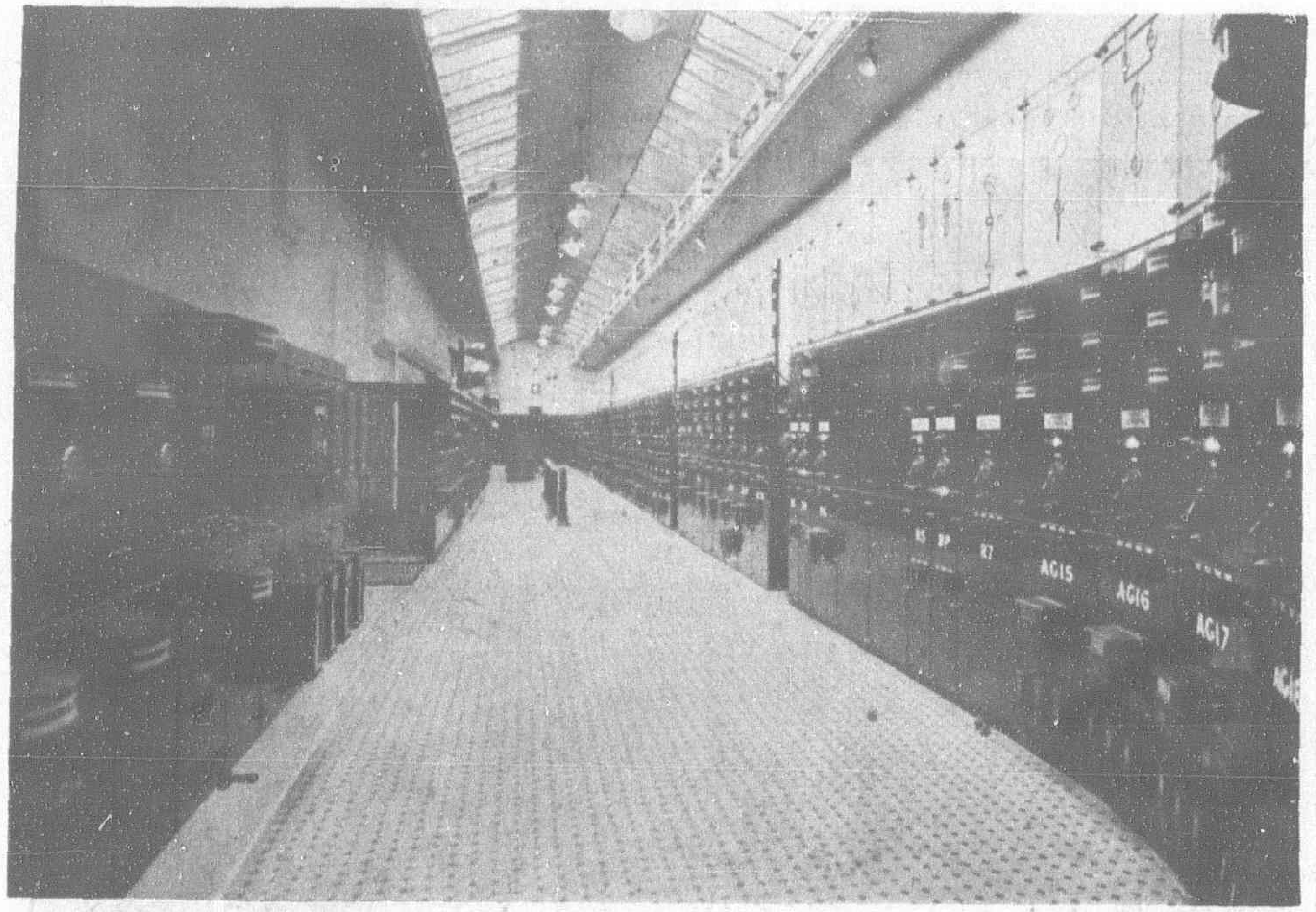
Two B. & W. water tube boilers and two Stirling tri-drum water tube boilers, each 140,000 lb. per hour normal and 185,000 lb. per hour maximum rating; firing equipment, Lopulco system bin and feeder pulverized fuel, with Murray fin side wall and back wall tubes and vertical fin type burners. These boilers are equipped with steel tube economizers and air preheaters, three of the latter are tubular type, the fourth being Howden-Ljungstrom vertical type. Draught, forced and induced. In the preparation plant Raymond mills and screw conveyors have been adopted.

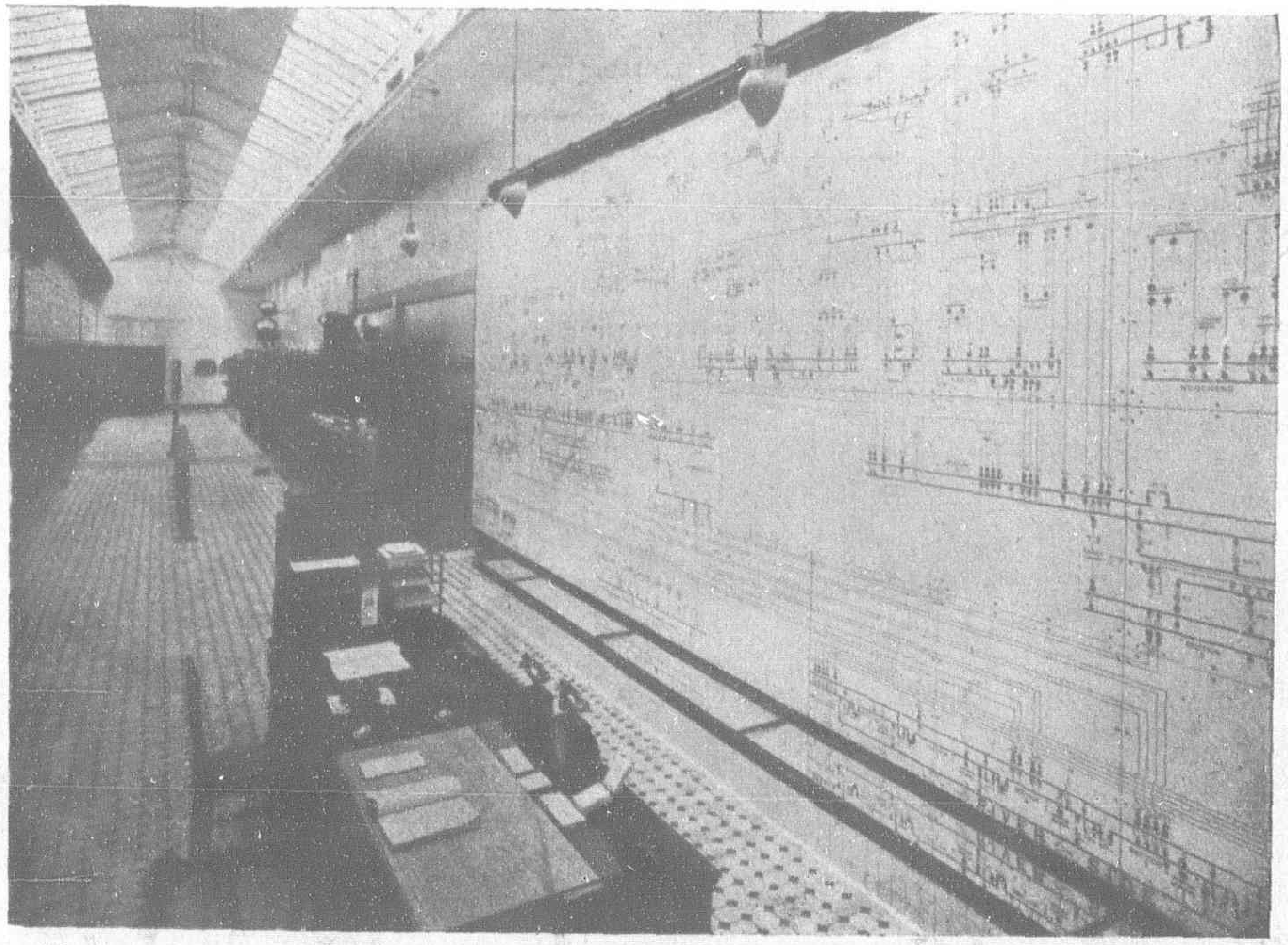
Boiler House Instruments.—Each boiler is fitted with a feed water Venturi meter, CO_2 meter, steam flowmeter, temperature indicators and recorders and all the apparatus necessary for efficient operation and heat balance data. All operating controls are located on the operating floor of the boiler houses.

Feed Pumps and Tanks.—The whole of this equipment, with the exception of the first section, is contained in a bay between the turbine room and boiler house. All normal duty pumps are of the rotary type electrically driven, and steam turbine driven and reciprocating types are available as standby. The feed system from the condensate pumps to the feed pumps is enclosed. Feed tanks are steam sealed, and condensate is admitted at the bottom. Normal water level in these tanks is approximately 21 feet above the centers of feed pumps.

Feed Water Heating.—As indicated in the foregoing tabulation in regard to operating conditions, feed heating in "A"

Riverside Power Station—1931 Control Room, looking South





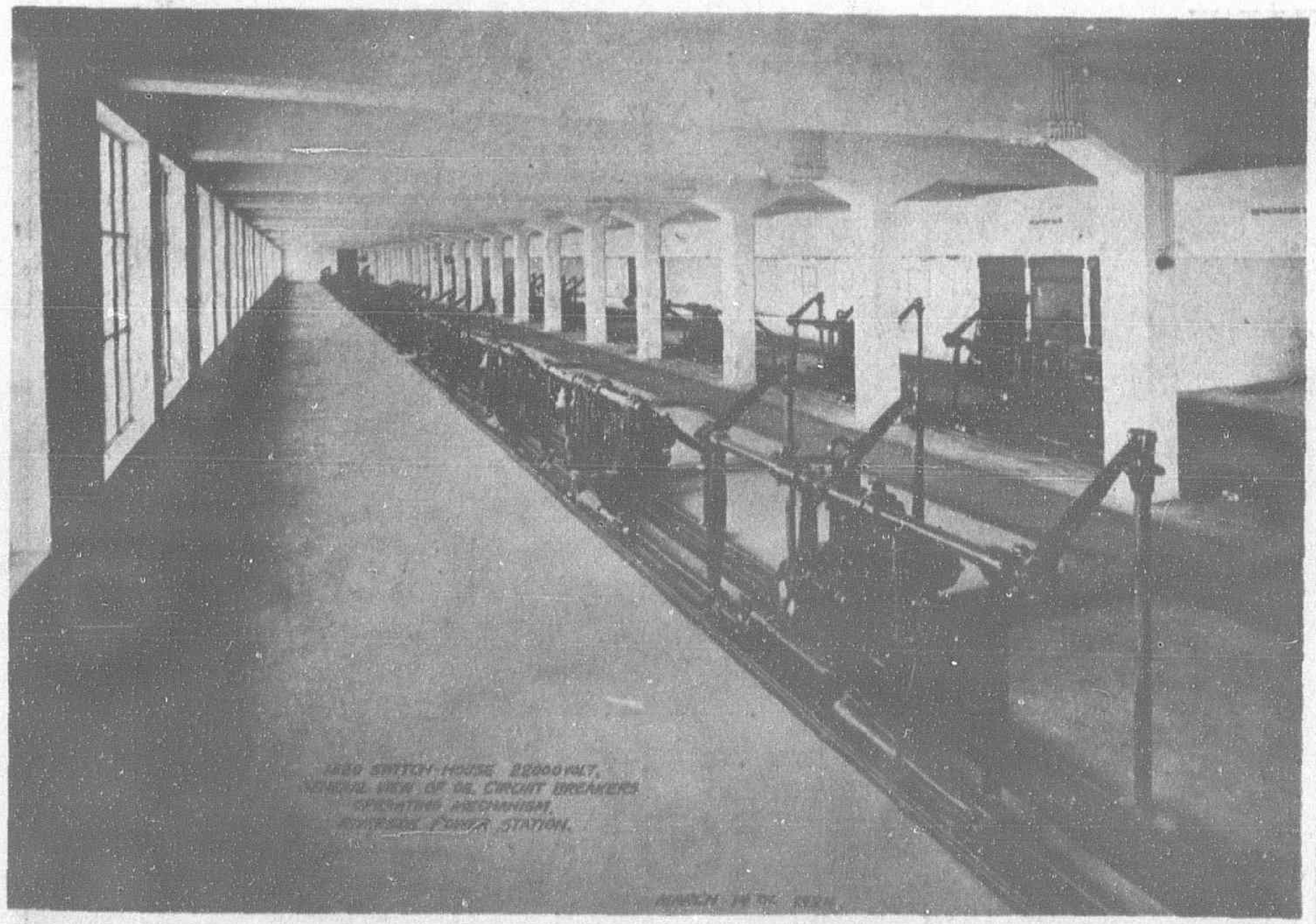
Riverside Power Station

1

Control Room looking south showing feeder controls on the right, auxiliary supply and generator controls on the left

2

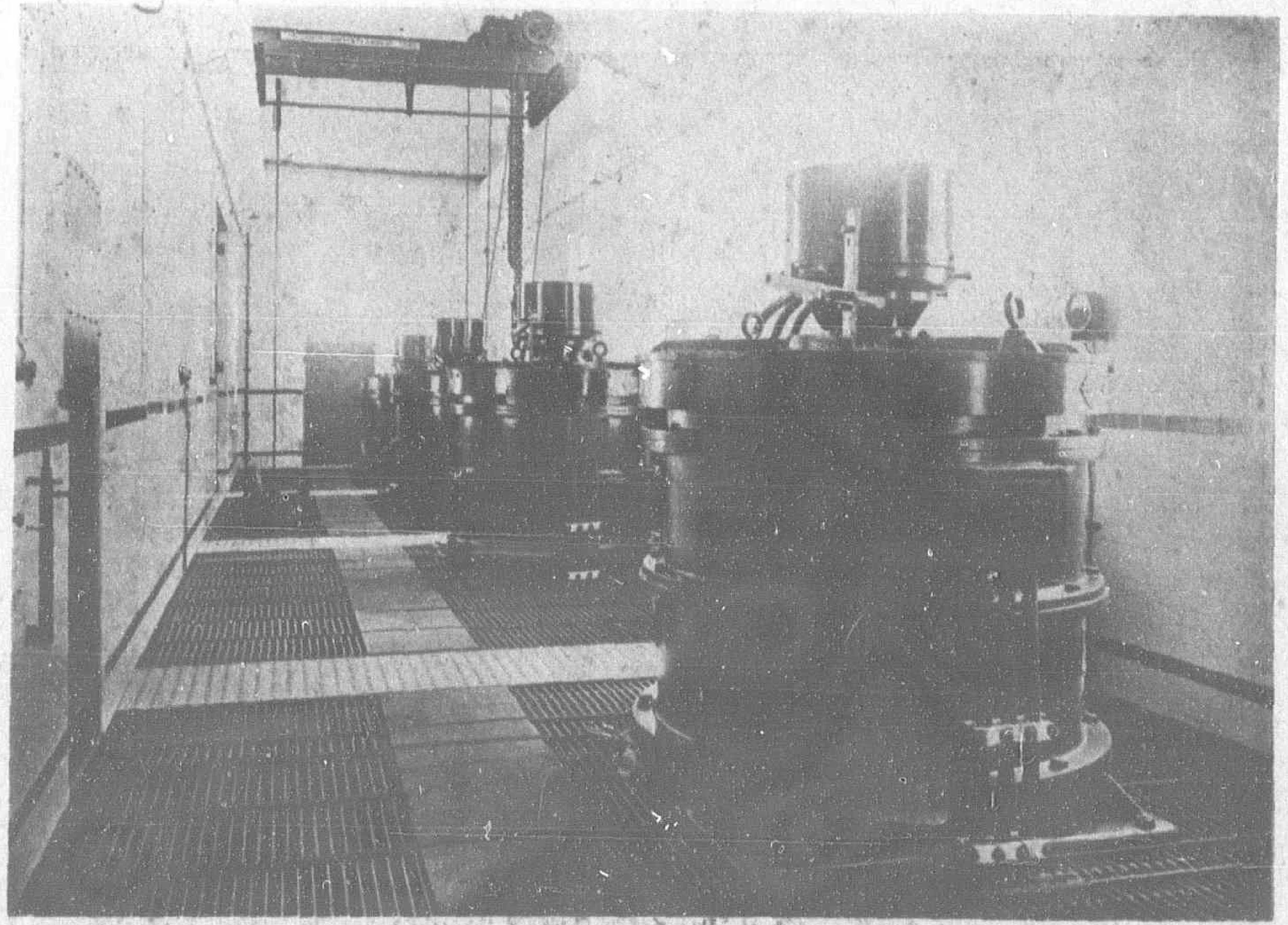
Control Room looking north showing distribution diagram in the foreground, generator and auxiliary supply controls on the right, feeder controls on the left


1480 SWITCH-HOUSE 22000 VOLT,
GENERAL VIEW OF OIL CIRCUIT BREAKERS
OPERATING MECHANISM,
RIVERSIDE POWER STATION.
MARCH 14TH. 1928.

22,000 Volt Switch House Operating Mechanism

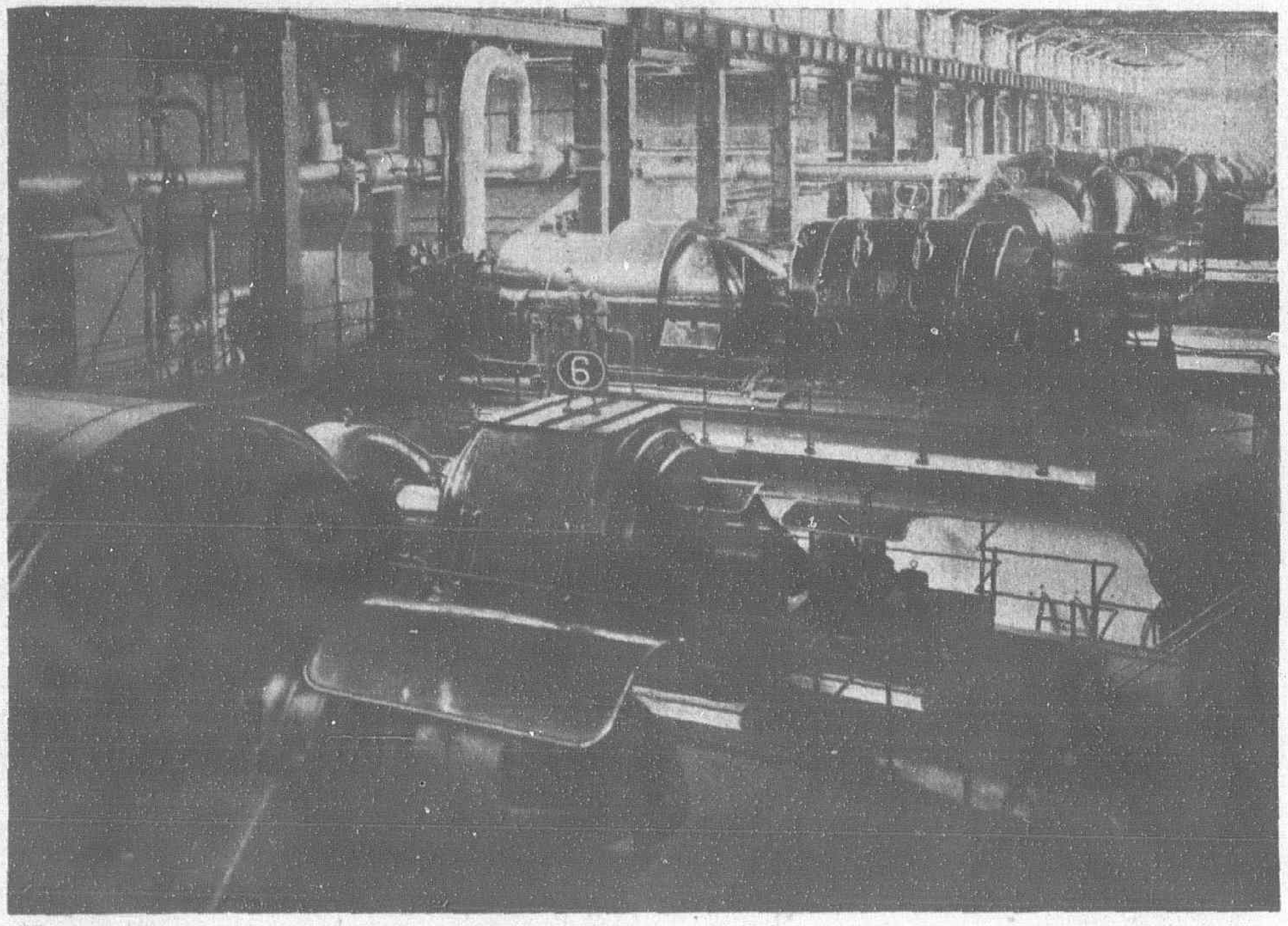
3

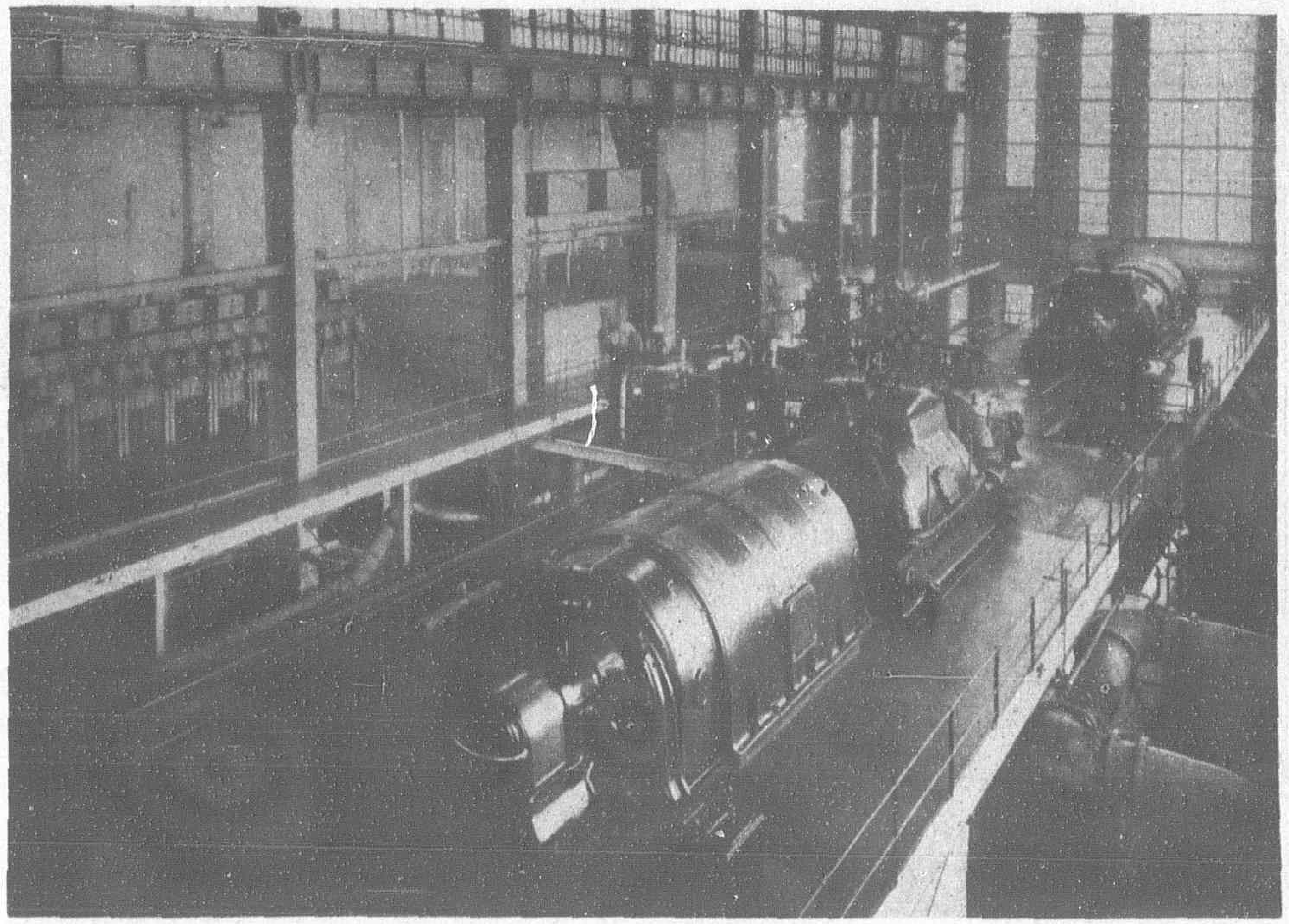
5



No. 3 Circulating Water Pump House

4

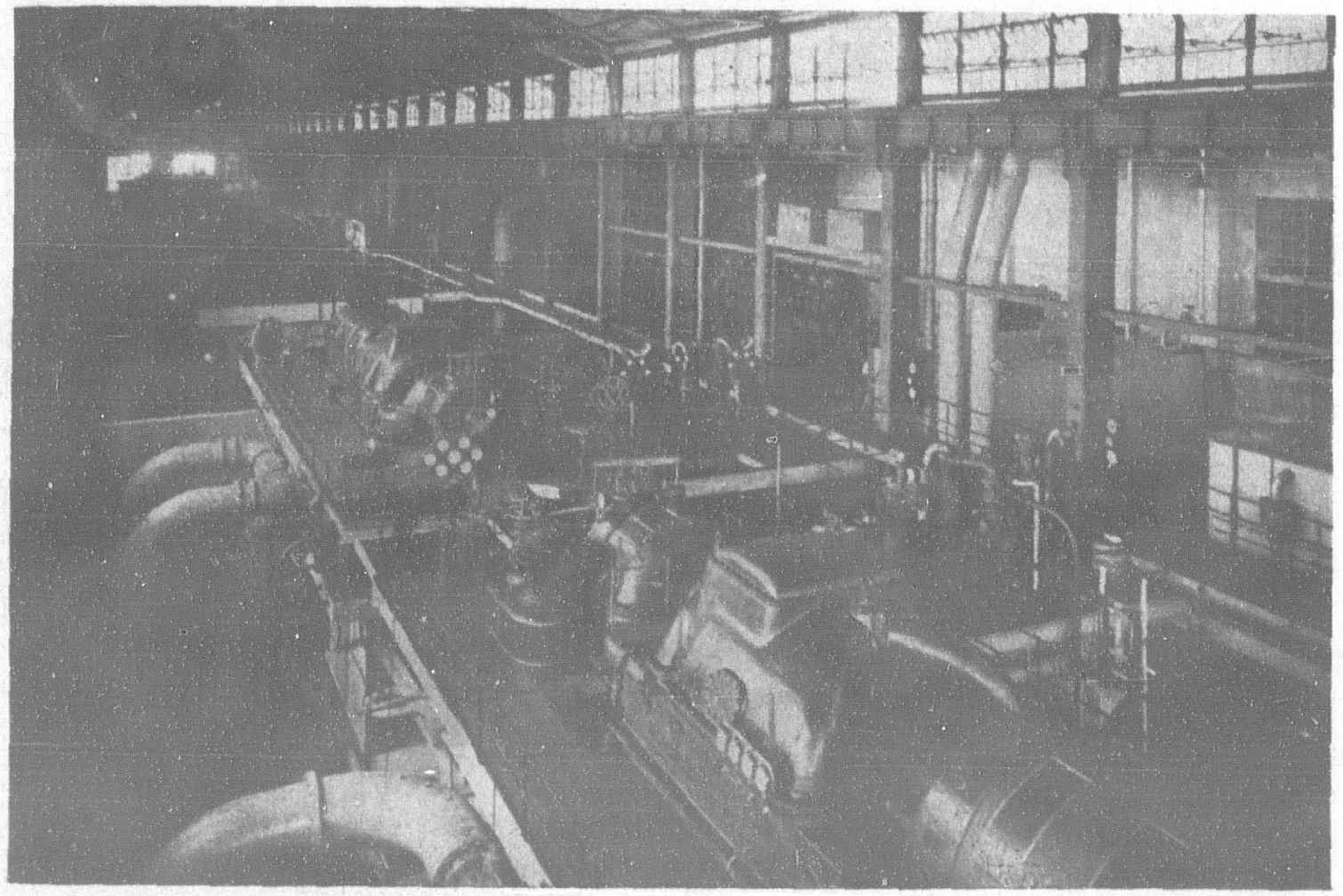


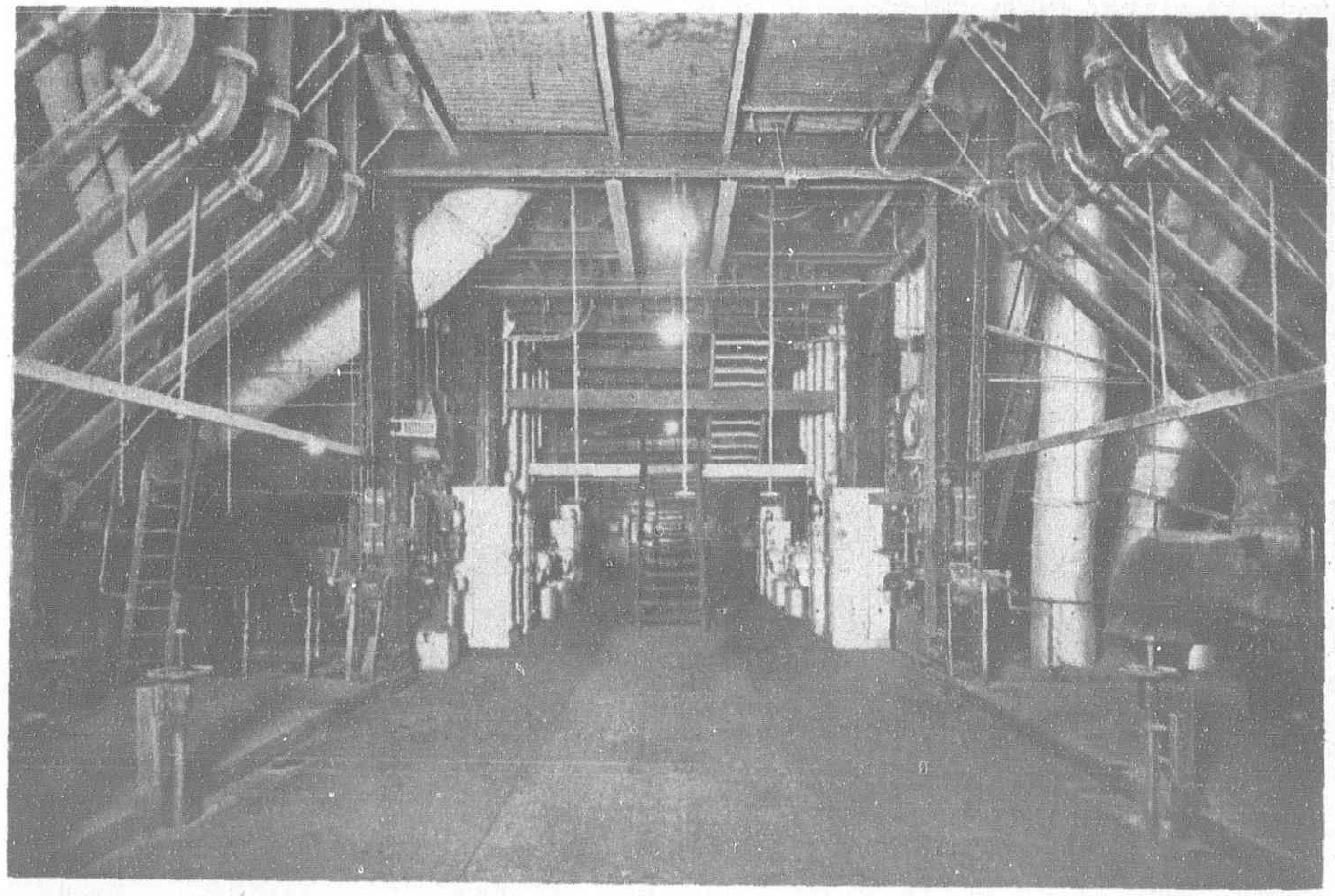


Riverside Power Station

1 "A" Station Turbine Room looking north. No. 5 machine in the foreground.

2 "B" Station Turbine Room looking north-west





Riverside Power Station

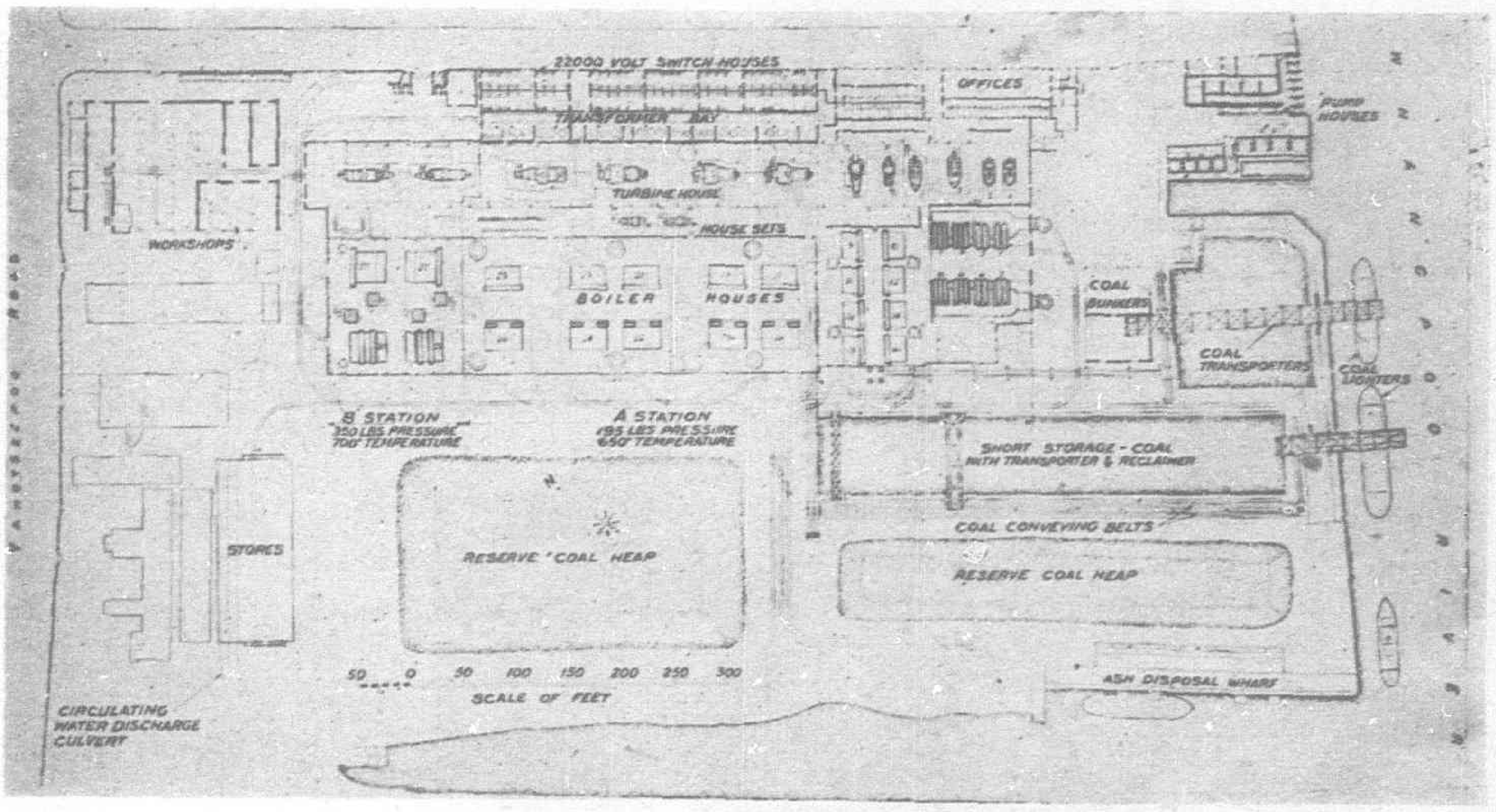
3 "A" and "B" Stations Turbine Rooms looking south. No. 15 machine in the foreground

4 "B" Station Boiler House. Pulverized Fuel Plant Operating Floor

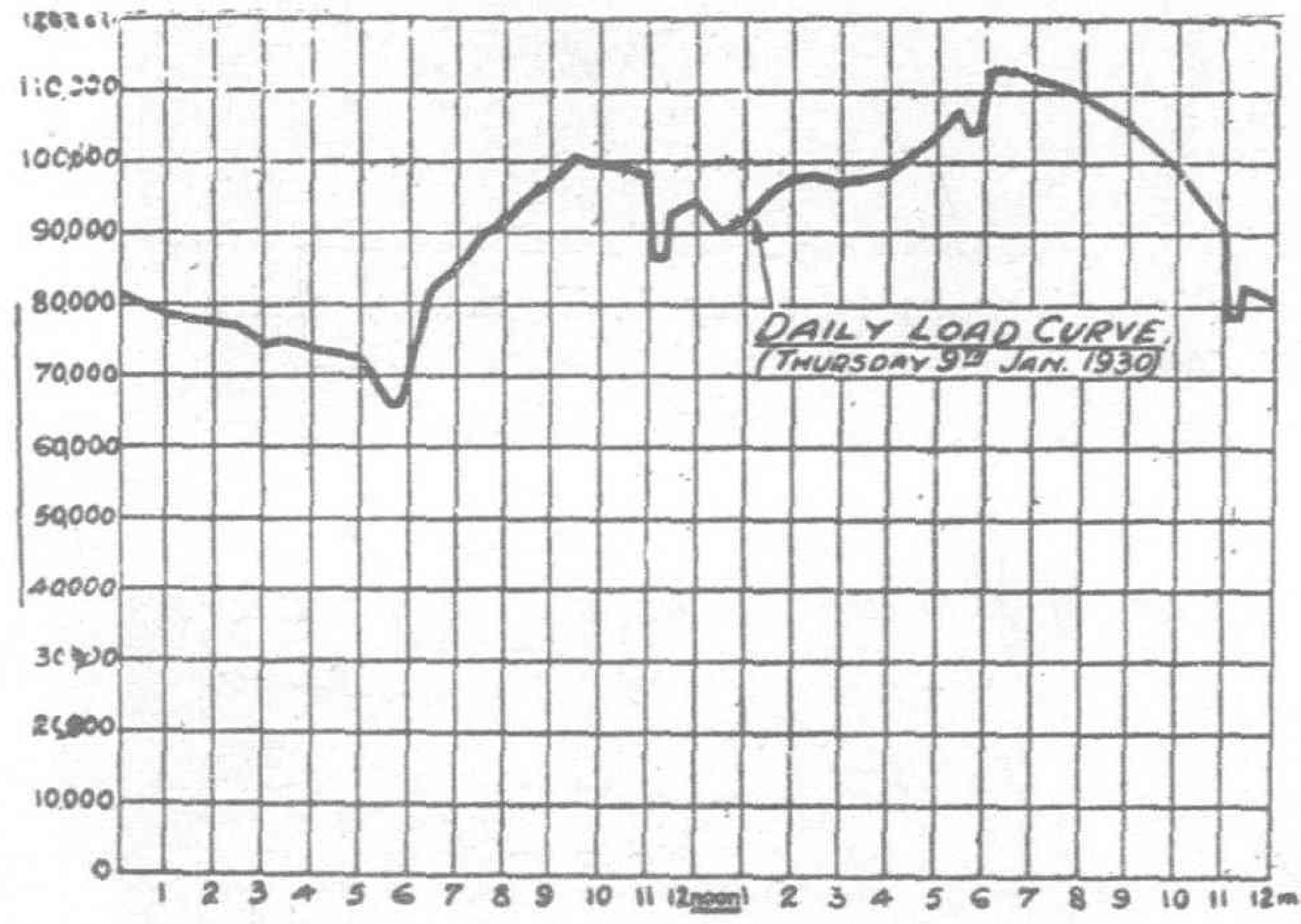
Station is effected initially by passing all condensate through the condenser of the running house service turbo alternator which operates normally at a vacuum between 13 and 15 inches (barometer 30″ Hg.) and further by the exhaust steam from the air ejectors of the main condensers. The final temperature at economizer inlet averages 195°F. These house turbo sets are referred to later under " Turbine House."

The feed water system in " B " Station is entirely separate from that in " A " Station, with the exception that in emergency the feed tanks can be coupled up through a common bus pipe. Initial feed heating is effected by stage bleeding. On one set two stage bleeding is employed with the heaters placed between the condensate extraction pump and the feed tanks, and on the other turbo set three stage bleeding is employed, two heaters being located between the extraction pump and the feed tank, and the third heater on the discharge side of the boiler feed pumps. The average temperature at inlets to economizers is 220°F. As a further precaution again aeration make-up water to the feed system is admitted *via* the main condensers.

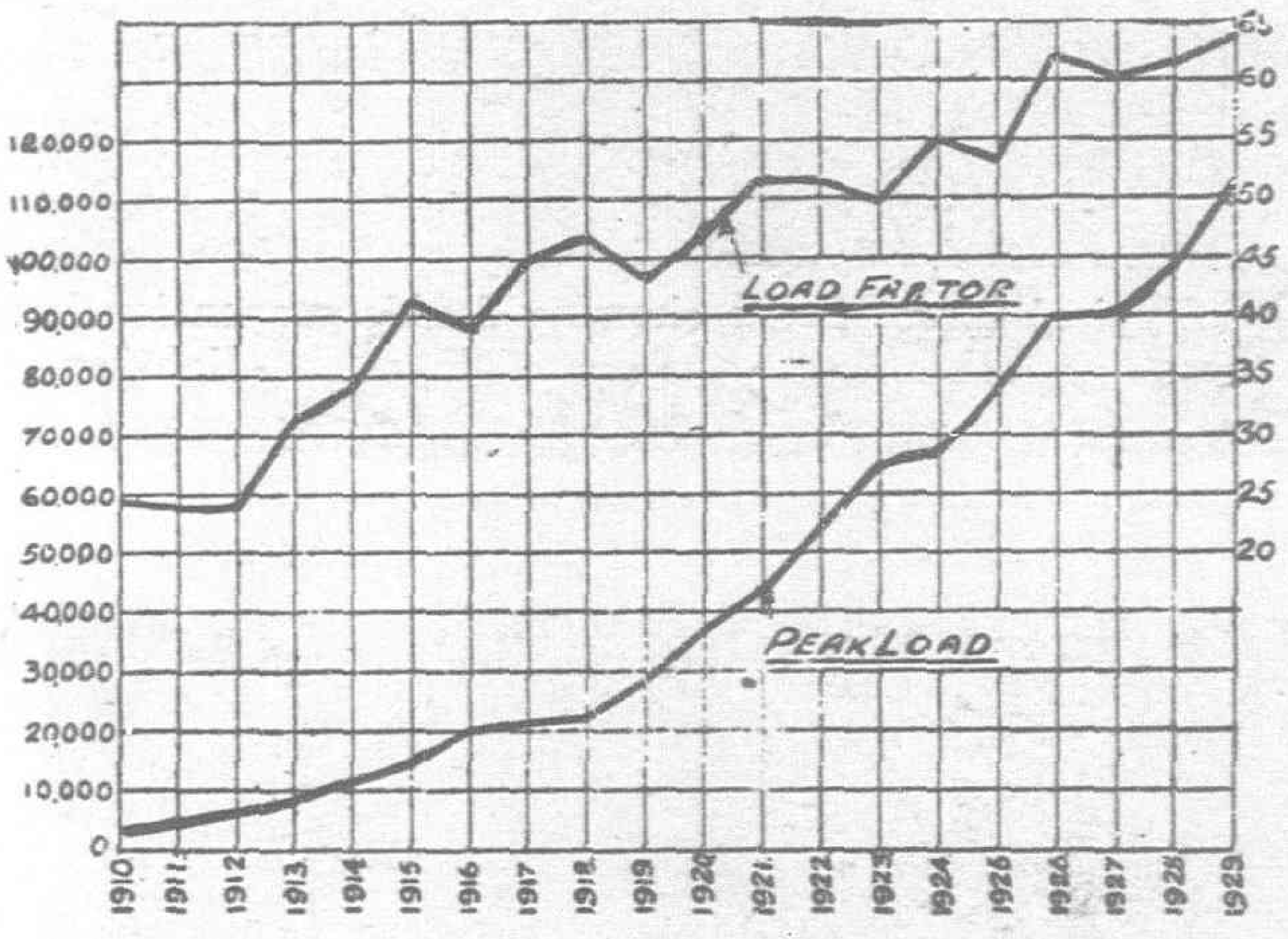
TURBO-ALTERNATORS " A " STATION.—Turbo-Alternators in " A " Station operate at 195 lb. per square inch, final steam temperature 600°F. In this section there are twelve turbo sets, as follows :—One 20,000 kw. Parsons ; one 20,000 kw. Metropolitan-Vickers ; two 18,000 kw. I.G.E. Co. ; one 10,000 kw. Parsons ; two 10,000 kw. I.G.E. Co. ; one 5,000 kw. Fraser & Chalmers ; two 3,000 kw. Metropolitan-Vickers (House Service sets) ; two 2,000 kw. A.E.G. The ratings referred to are maximum continuous. A view looking from the north end of the station will be found on page 288.



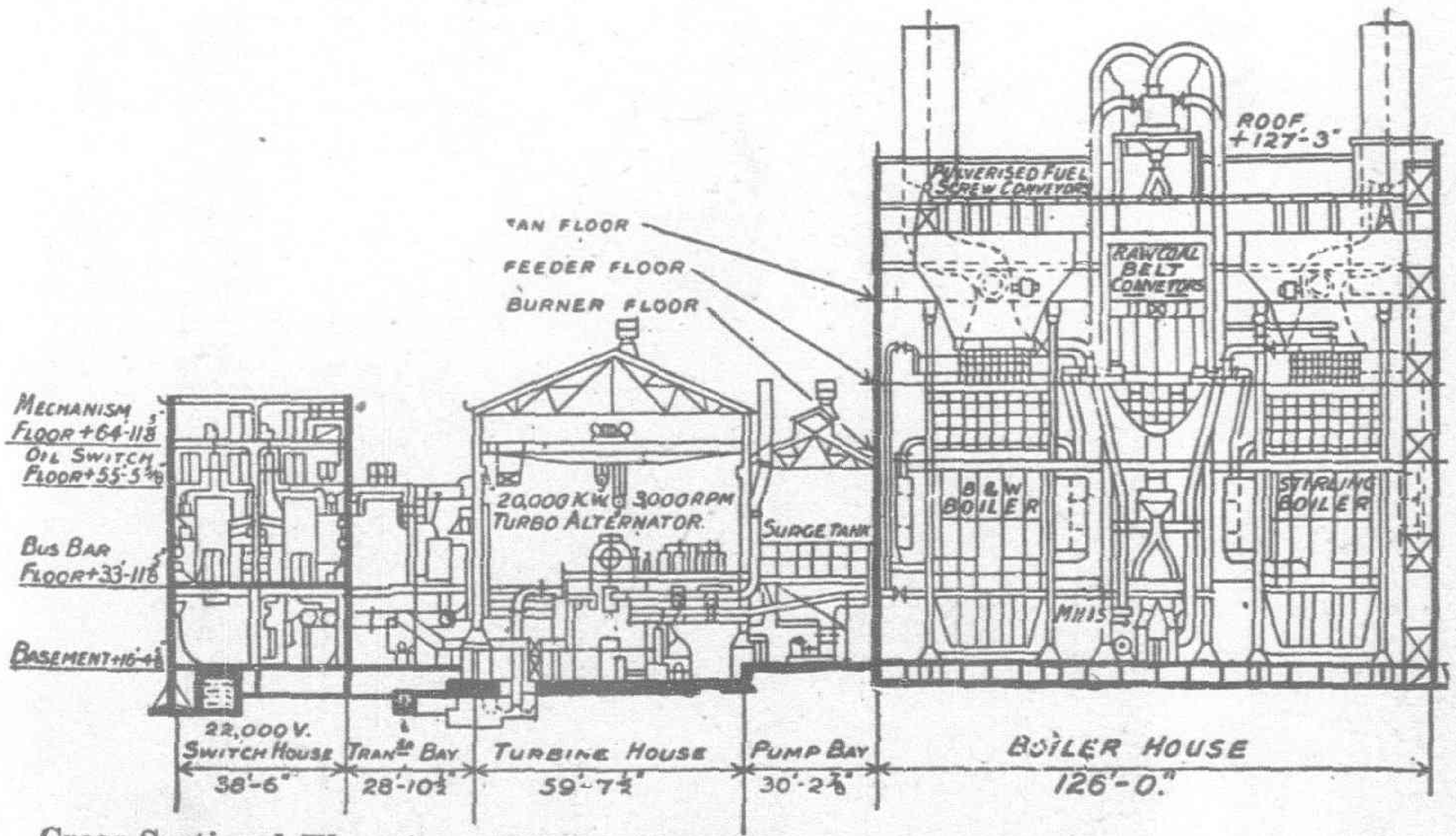
General Layout; Riverside Power Station



Typical Daily Load Curve at Riverside Power House



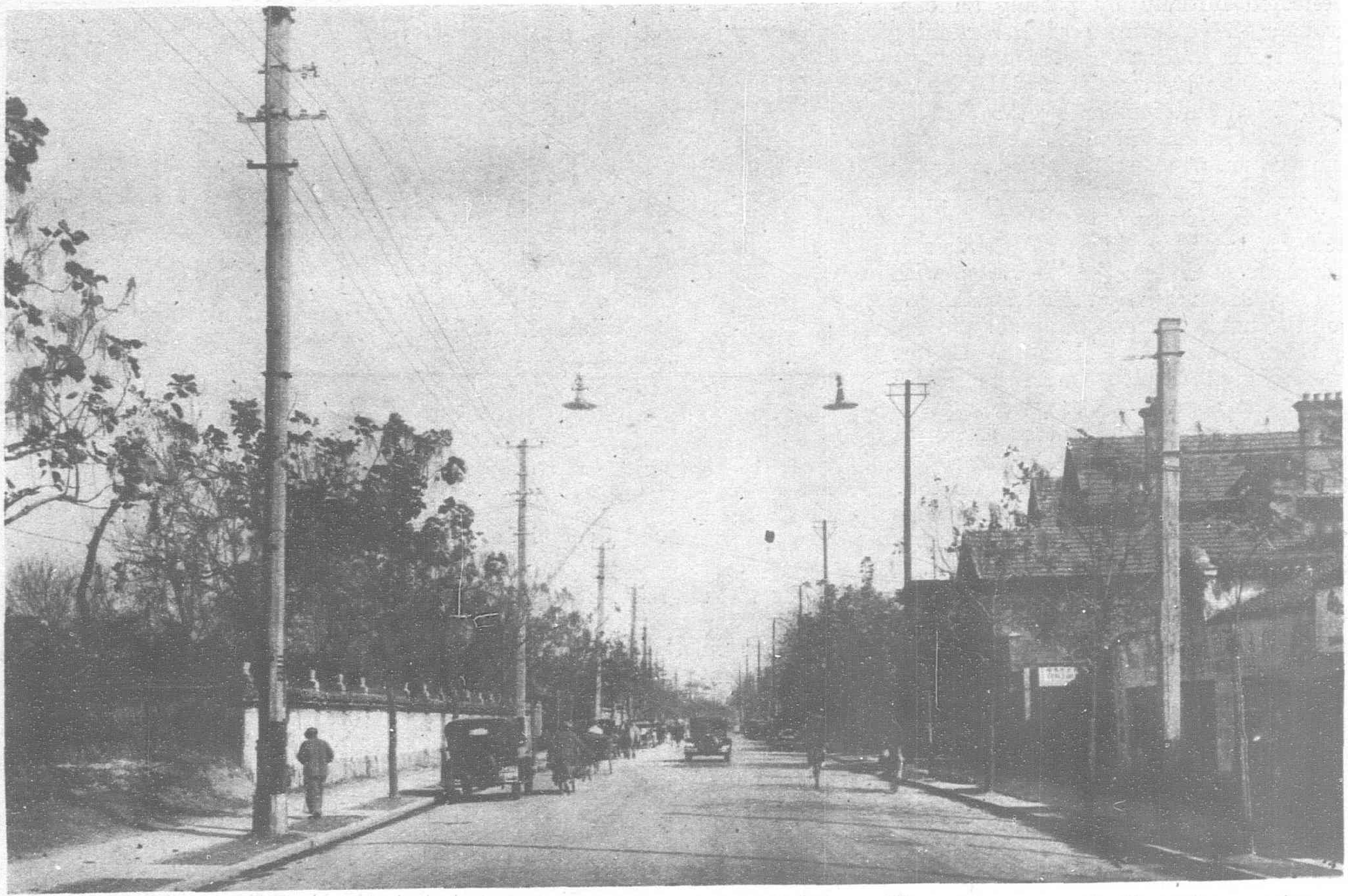
Maximum Demand and Load Factor for the years 1910 to 1920, Riverside Power House



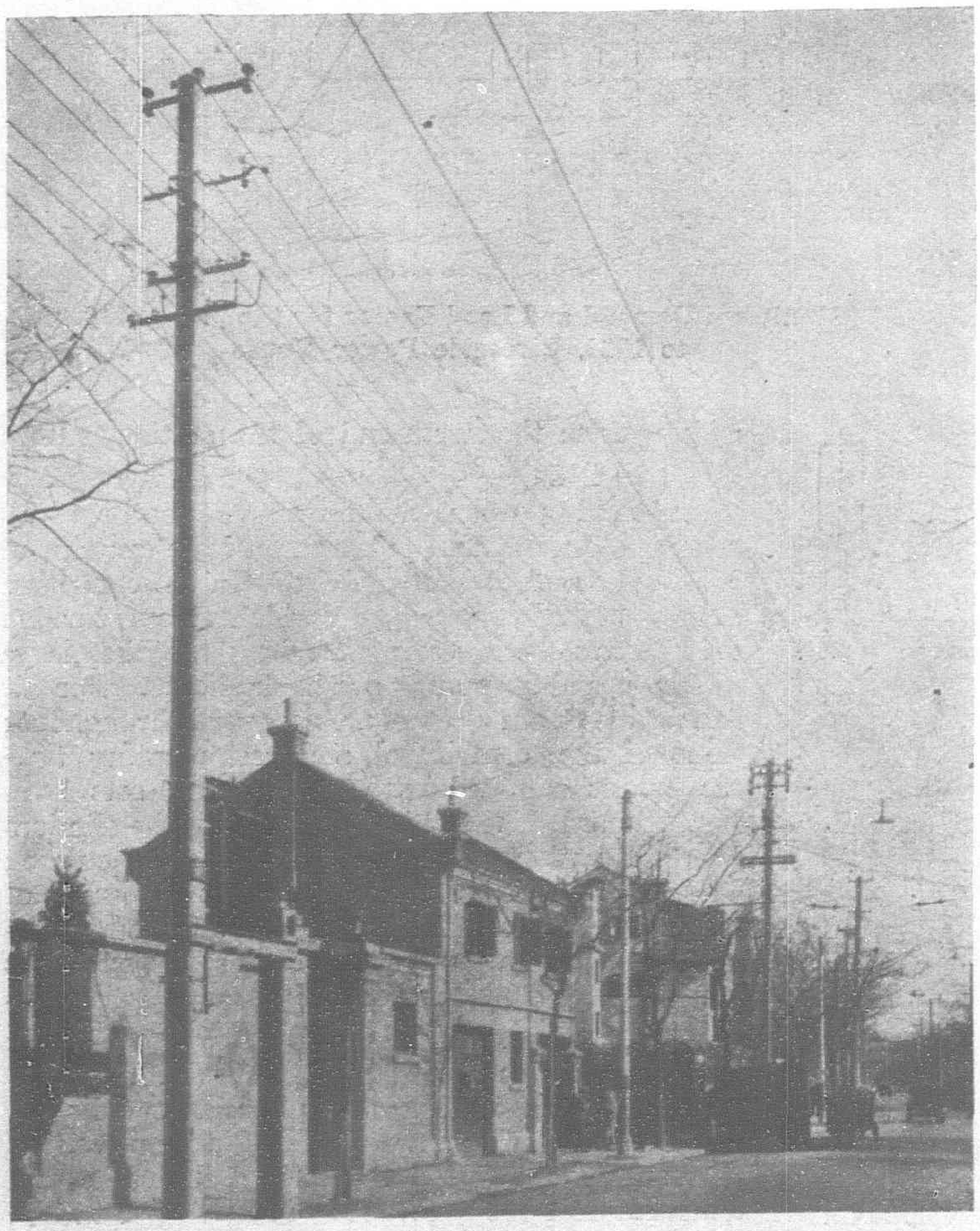
Cross-Sectional Elevation of "B" station, Riverside Power House Extension. With regard to the switchgear houses (here shown on the left) there are two of these adjacent to one another, one containing 6,600 volt and the other 22,000 volt main switchgear. Cable boxes are in basement; bus-bars, solating and selecting links protective gear and instrument transformers on the first floor; oil switch operating mechanism on the third floor

Touching upon the important features, all condensate extraction pumps are of the centrifugal type and are electrically driven, with the exception of two standby pumps, on which steam turbine drive have been adopted. On all the large generating units pumps are in duplicate. For air extraction steam ejectors are now used throughout; some of the centrifugal and reciprocating type air pumps supplied with the earlier sets have been discarded, the chief object being the elimination of aeration. Condensers are all surface type ; those on the larger units being split to permit of cleaning without taking turbo sets off load. Also on these large units the enclosed system is employed for alternator cooling.

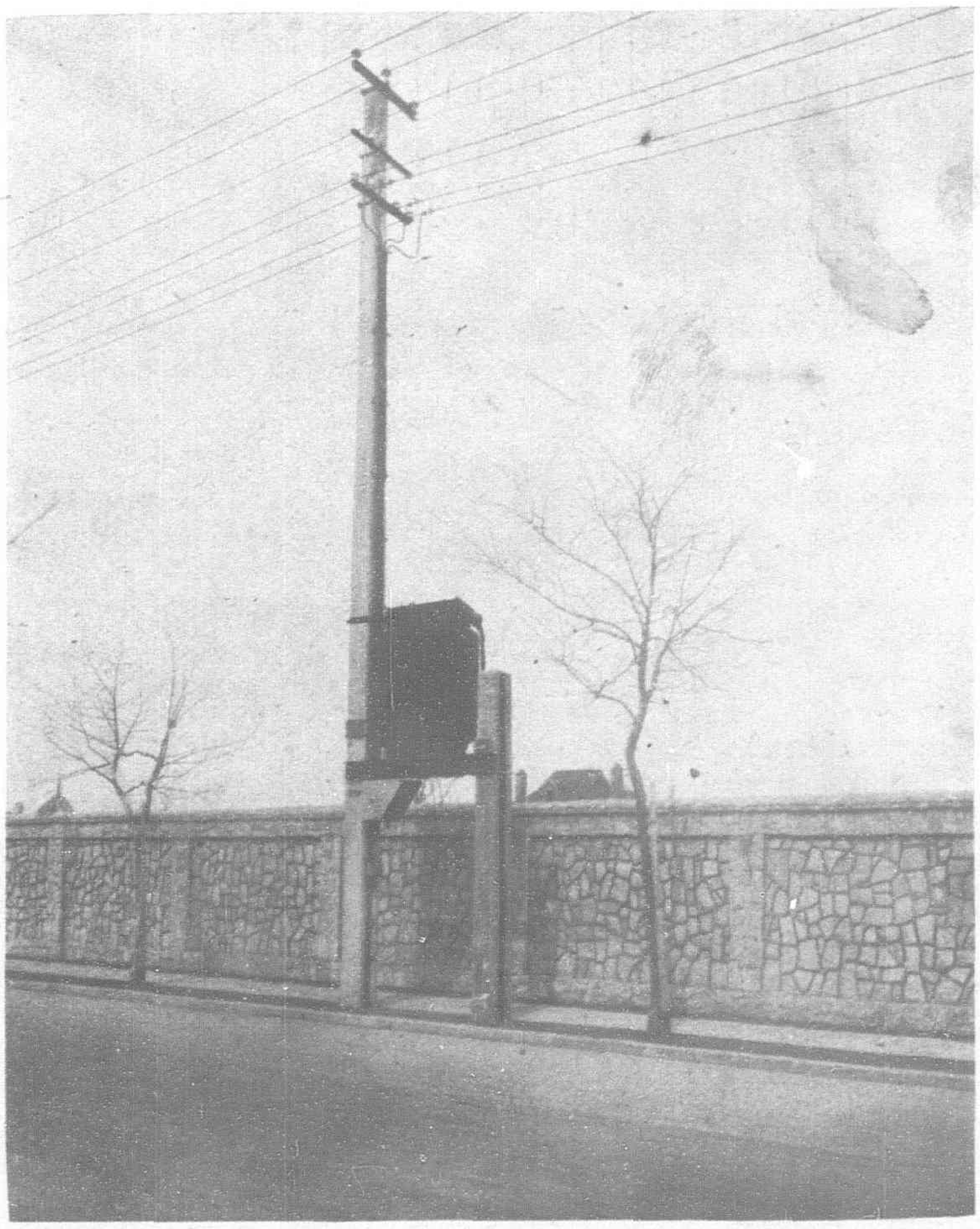
TURBO-ALTERNATORS " B " STATION.—This section contains two 20,000 kw. (M.C.R.) Metropolitan-Vickers turbo-alternators, twin cylinder, 3,000 r.p.m., which are designed to operate at steam pressure 300 lb. sq. in. and final steam temperature 700° F. As in " A " Station, electrically driven condensate extraction pumps, in duplicate, split condensers to facilitate cleaning, and steam air ejectors are employed.



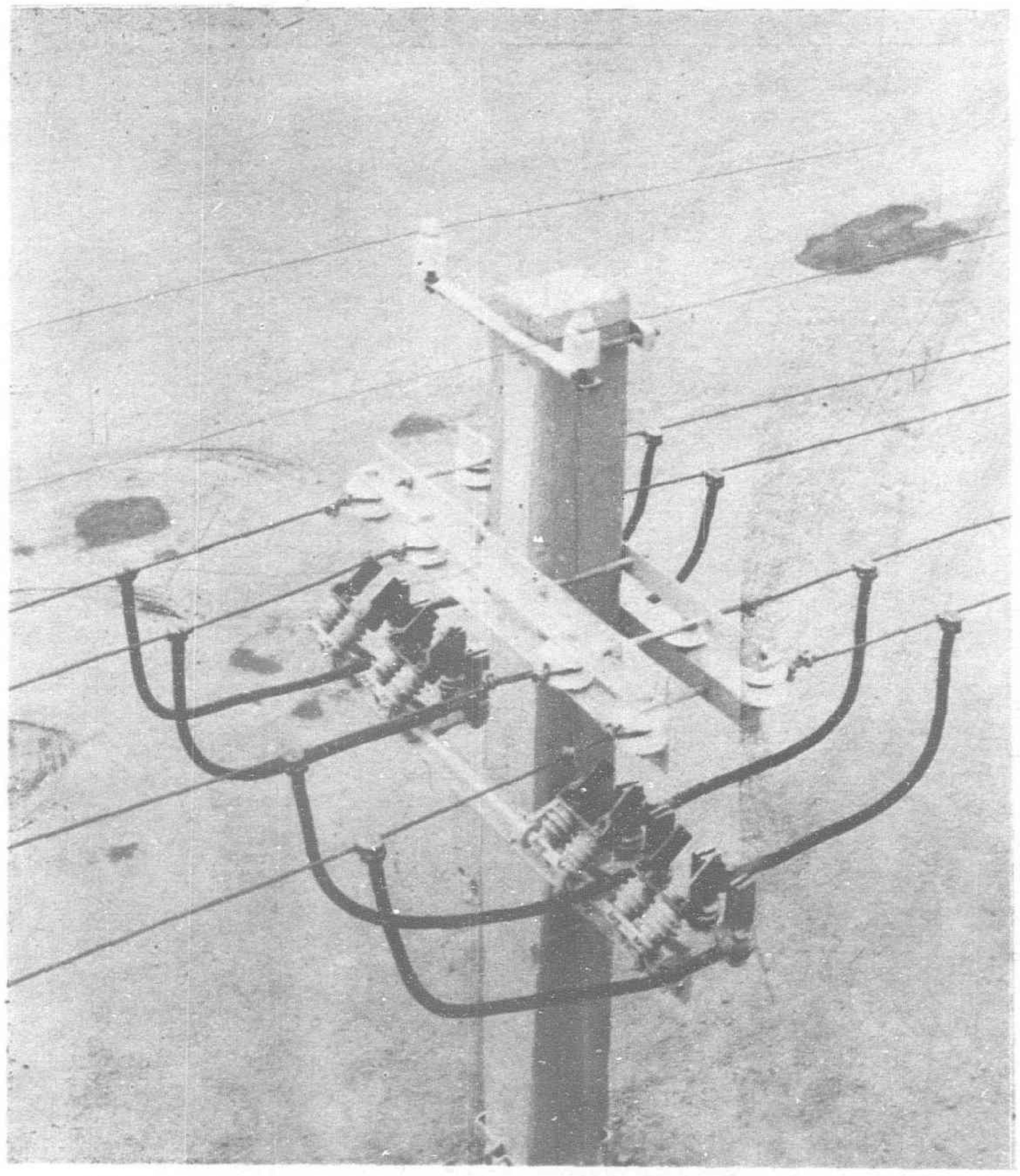
Typical Street Scene shewing double suspension lamps for street lighting. The poles carry L. T. mains, series lighting circuits and 6.3 kv. mains



125 kva. Pole Transformer on concrete poles supplied from the 6.3 kv. overhead mains via a lever operated live switch and underground cable. Line switch mounted on adjacent pole. Also shows public lighting circuits with suspension fittings



225 kva. Pole Transformer supplied by underground cable at 6.3 kv. supplying 350v. overhead mains. Also public lighting and 6.3 kv mains on same pole



L. T. Lever operated line switch mounted on pole. Also shows general type of L. T. sectionalizing on breaking bracket. Two series public lighting circuits on pole top

Turbine House Instruments.—Each turbo-alternator set is equipped with all the instruments necessary for efficient operation and maintaining a check on performance ; for condensate measurement Venturi and Electroflow meters are employed. In addition the turbine house is fitted with calibrated test tanks which can be connected through a system of piping to any turbo set for the purpose of checking meters and/or obtaining accurately at any time steam consumption data.

Circulating Water System.—Circulating water is drawn from the Whangpoo River, which is tidal, the maximum rise and fall being 12 feet. The pumping plant is situated on the river bank, and from the general plan, it will be seen that this is divided into three sections which contain eleven pumps having a capacity of 20,000 g.p.m. each, and two pumps of 35,000 gallons per minute. of these nine have been supplied by Allens, Bedford, two by Worthington, U.S.A., and two by Mather & Platt, Manchester. Travelling screens are fixed at the mouth of intake channels to supply Nos. 1 and 2 sections, and stationary screens cover the intake for No. 2 section. All pumps are of the centrifugal vertical spindle type, a.c. motor driven. They are contained in chambers of concrete construction, the centers of pumps being 2 feet below low tide level so that under all conditions of tide the pumps are flooded.

Circulating Water Pipes.—These are in the main steel spigot and socket.

The circulating water system is syphonic, each condenser discharging into an underground culvert common to all sets, running east of the Turbine House and round the north side of the station, terminating in an open channel on the west side, which connects with the Whangpoo River at a point 200 yards from the intake (see general plan). The water of the Whangpoo River, whilst being comparatively free from vegetable matter, contains an abnormal amount of suspended matter which varies considerably with the tides and seasons, the maximum by weight in parts per million being 1,100. The temperature varies between 40°F. and 90°F., the average throughout the year being 65°F.

Operating Conditions—Electrical.—All alternators operate at 6,600 volts, four of the smaller sets being connected to the 6,600 volt section, the remainder, with the exception of the house service sets, supply energy to the 22,000 volt sections through step-up transformers, with switchgear on the 22,000 volt side only. The two house service sets operate at 6,600 volts and are connected to the station auxiliary switchboard—the latter is connected by step-up transformers to the 22,000 volt section.

Transformers.—The main step-up transformers are located in a bay between the Turbine Room and Switch House. A rail track and bogey running parallel to these transformers provide facilities for quickly replacing when necessary the transformer units by the spares which are kept available for this purpose in this section. The oil cooling and purifying plant is in the basement immediately below these transformers.

Main High Tension Switchgear 6,600 and 22,000 Volts.—From the general plan it will be noted that there are two adjacent switch houses, one containing 6,600 volt, and the other 22,000 volt main switchgear. The whole of the switchgear is of the cellular type supplied by the International General Electric, U.S.A., and British Thomson-Houston, England. The building is of steel and reinforced concrete, as is also the cell construction. The cable trifucating boxes and lightning arrestors are contained in the basement, bus-bars, isolating and selecting links, protective gear and instrument transformers are on the first floor, oil switches and reactances on the second floor, and oil switch operating mechanisms on the third floor. The main 22,000 volt bus-bar is sectionalized, and is equipped with reactors which can be introduced between sections, the allocation to each section being approximately 20,000 kw.

Control Room.—The control room is situated between, but quite separate from, the turbine house and switch house. In addition to station control, h.t. network control is also carried out from this point, and a diagram of the whole of the h.t. network, with hand-manipulated discs to indicate the position of switches, etc., forms a part of the control equipment.

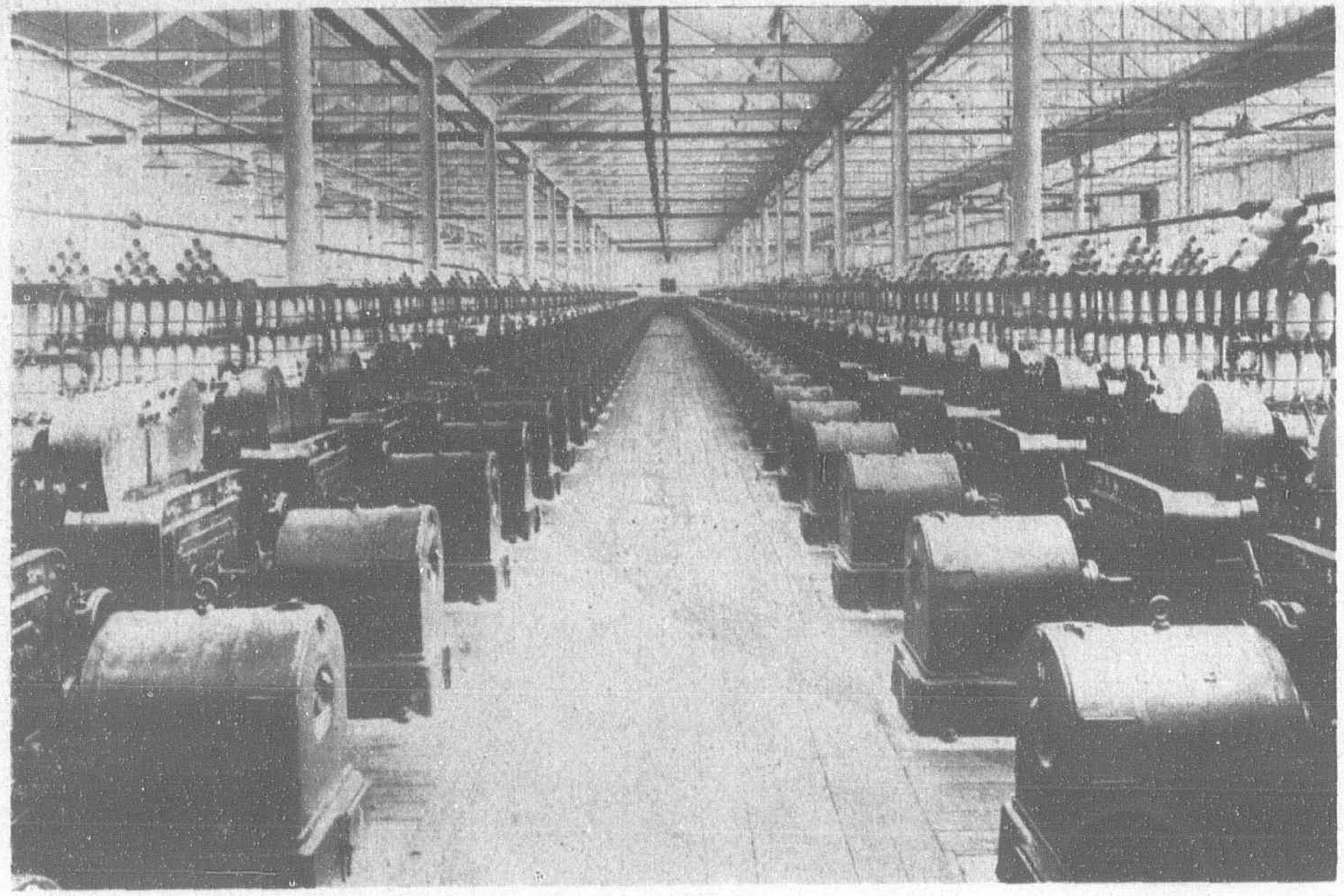
Supply to Auxiliaries.—With the exception of two circulating water pumps which operate at 6,600 volts, all other electrically driven auxiliaries are 350 volts a.c., or 440 volts d.c., the latter is employed in all cases where speed control is required. For a.c., d.c. conversion rotary convertors and motor convertors are employed.

In order to ensure continuity of supply to auxiliary plant under all conditions, supply is given to auxiliaries of approximately 80,000 kw. of generating plant from the house service turbo-alternator sets already referred to, and as previously mentioned, these house service sets generate direct on to a 6,000 volt auxiliary supply board, which in turn is connected to the 22,000 volt section through interconnector transformers. The switches controlling these are fitted with reverse power relays, the function of this apparatus being automatically to disconnect the house service supply from the main 22,000 volt bus-bars in the event of a

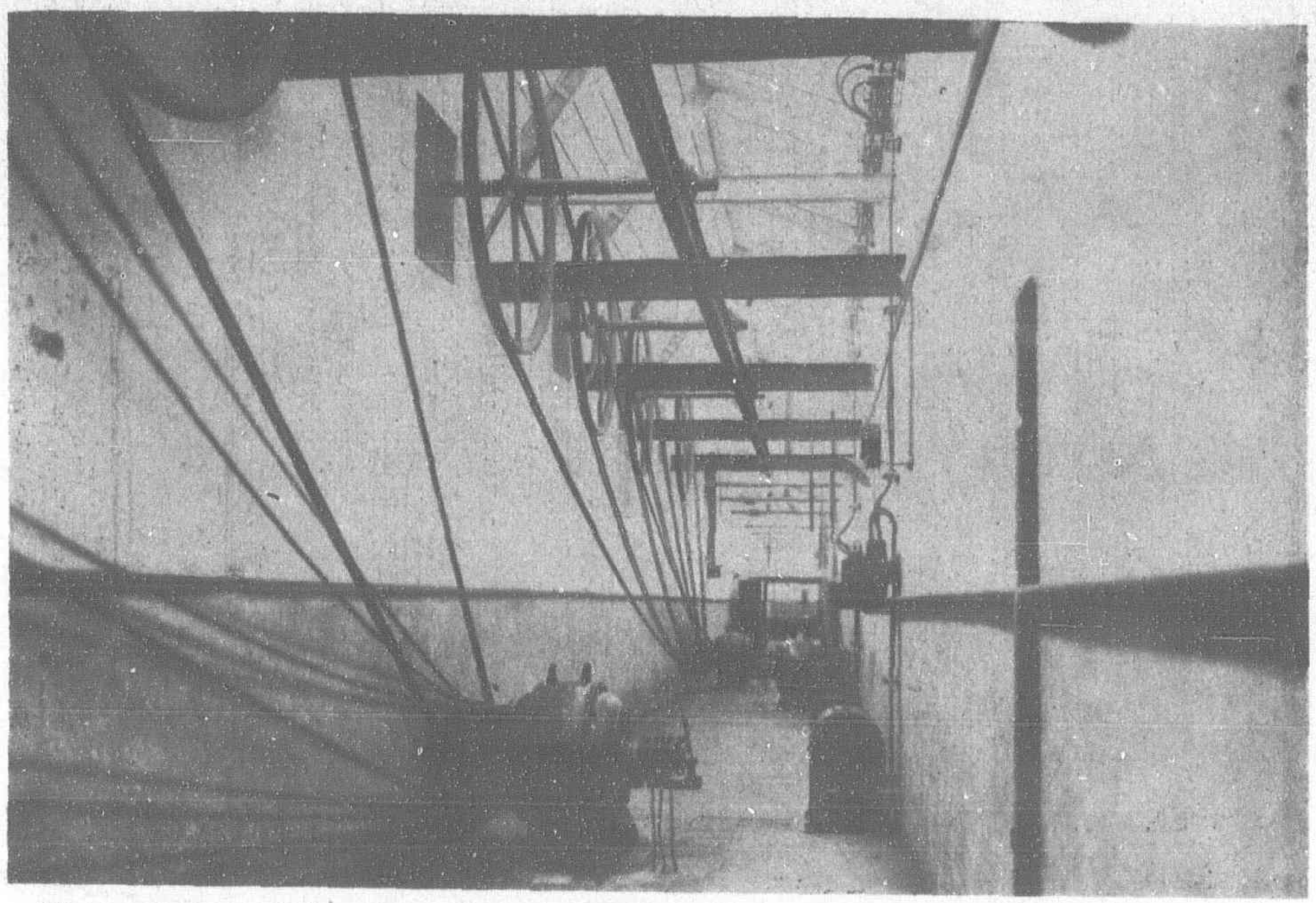
A row of 12-22,000 volt cables by the side of the trench in Shanghai from British Insulated Cables, Ltd.

TYPICAL INDUSTRIAL POWER DRIVES IN SHANGHAI

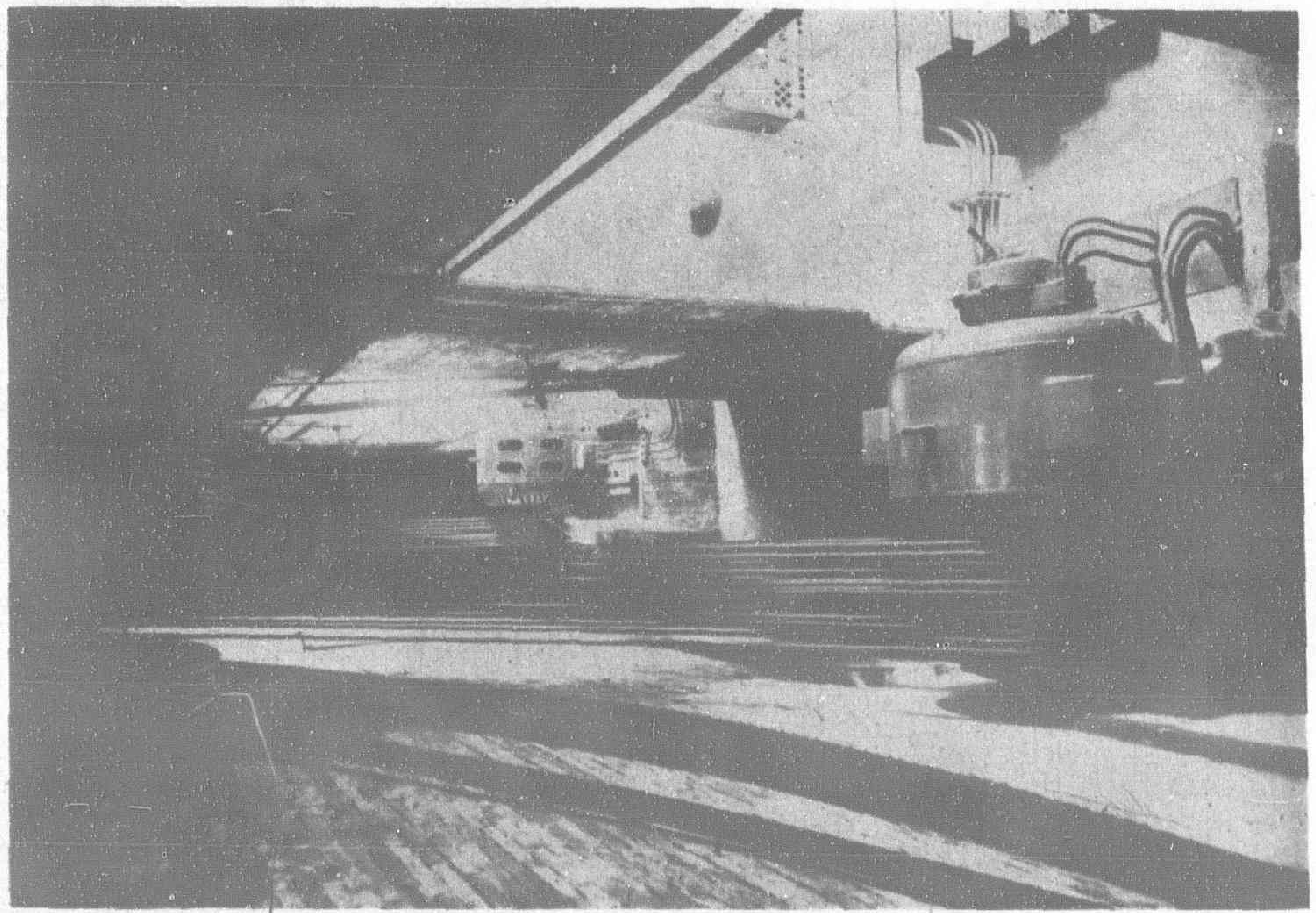
Power Supplied by the Shanghai Power Company



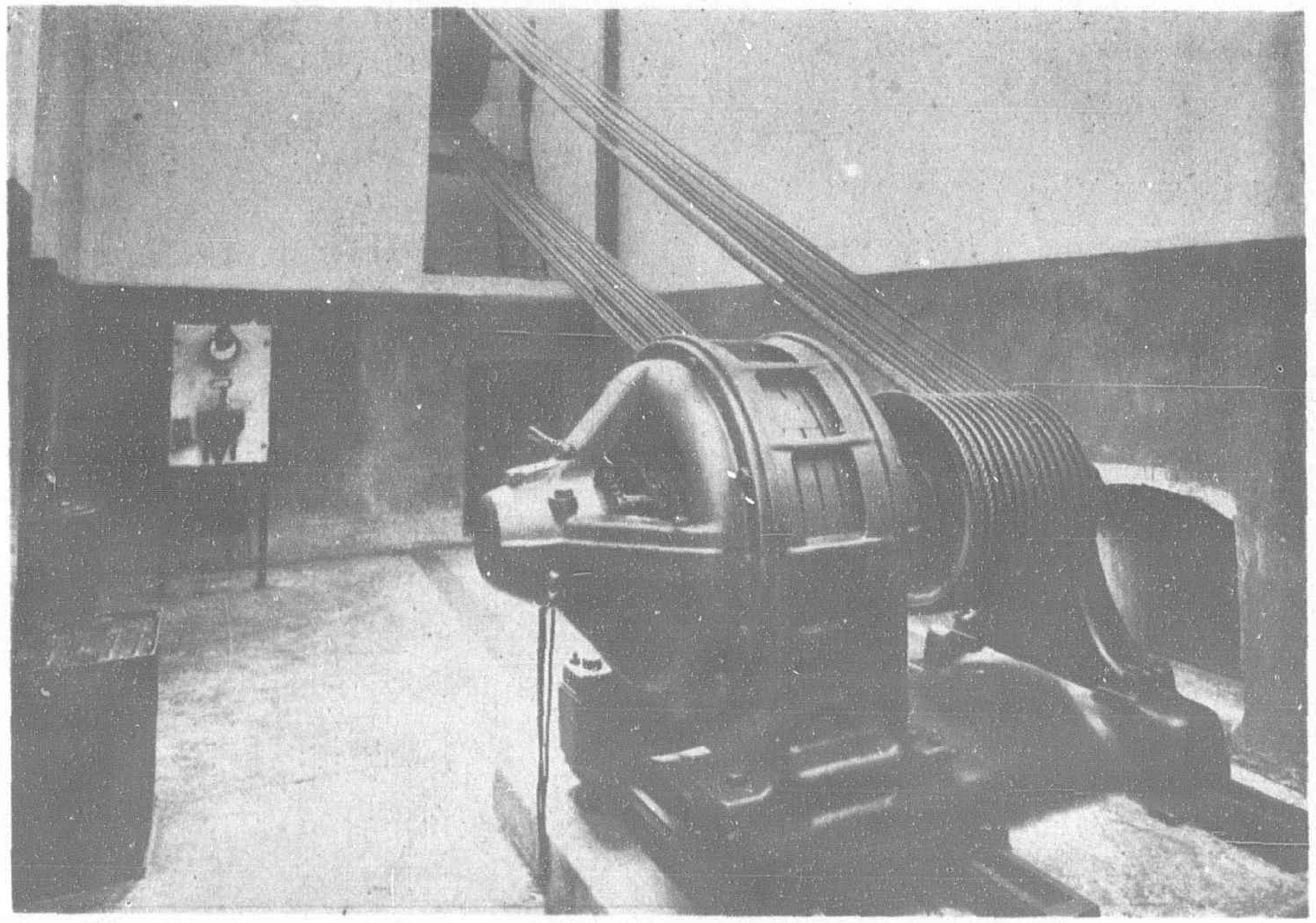
Individual Drive for Spinning Frames



These 80 h.p. Motors have been Running for 15 Years in a Cotton Mill without breakdown

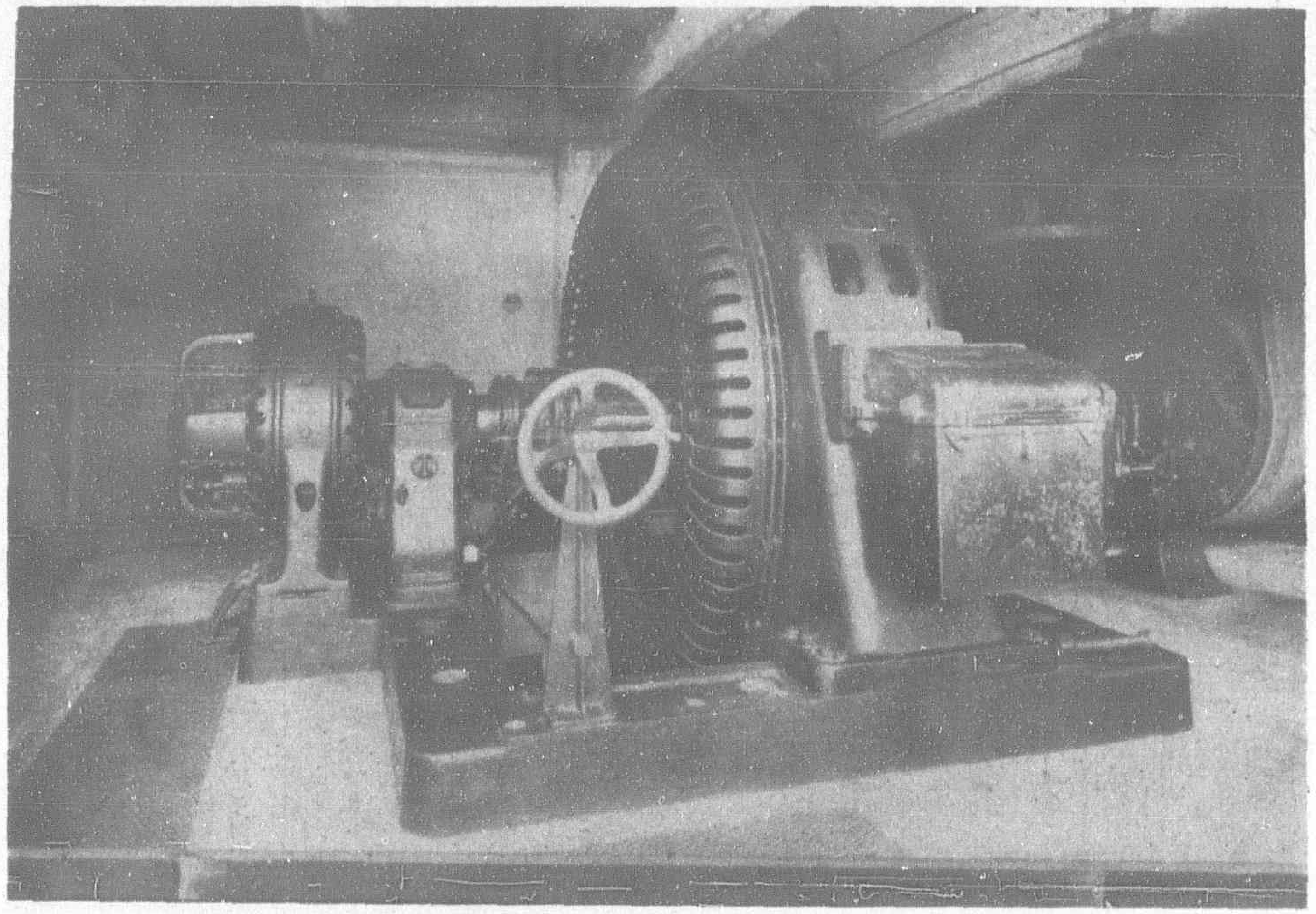


200 h.p. and 150 h.p. Motors Replacing Steam Engine in a Cotton Mill

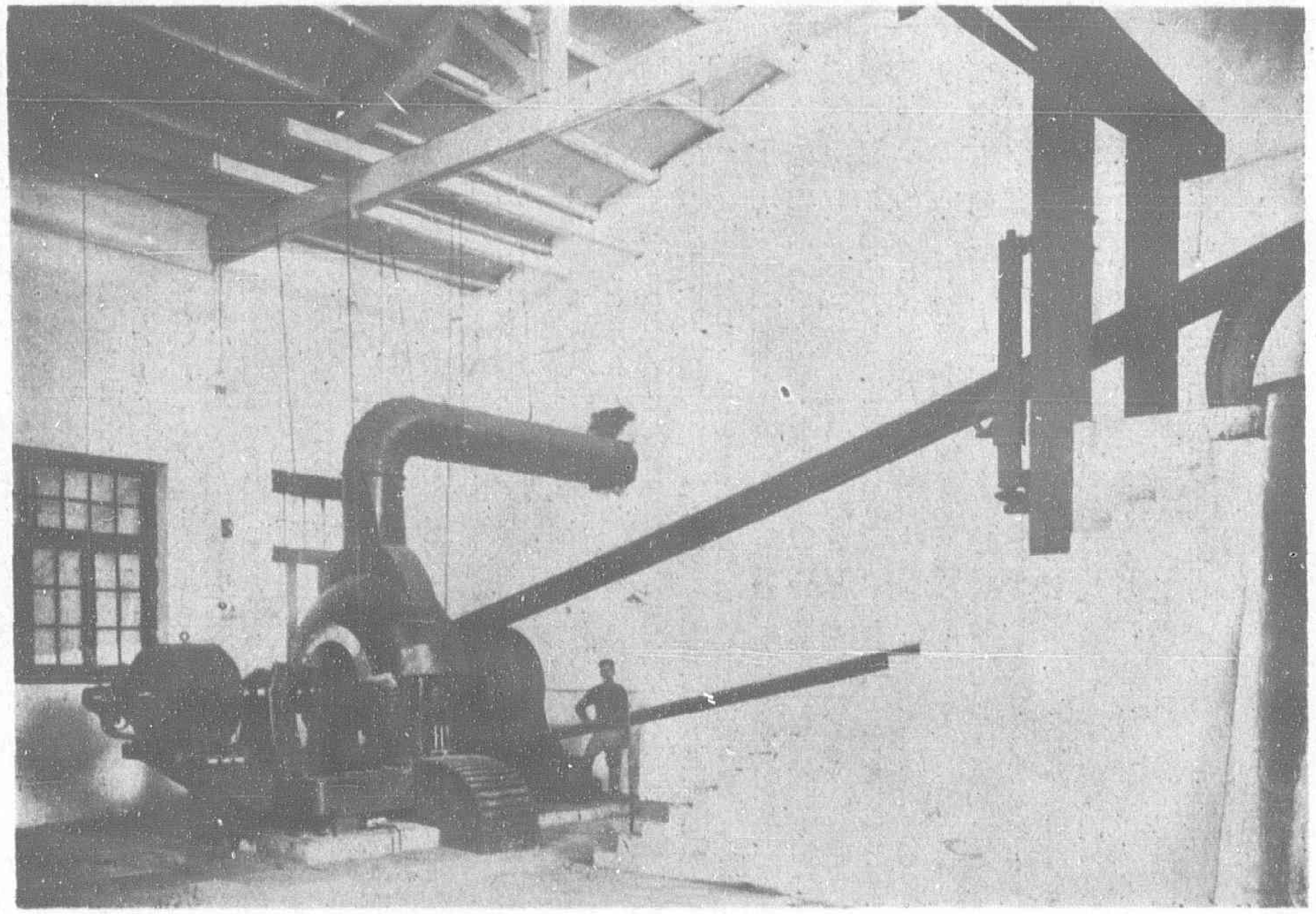


150 h.p. Motor Driving Ring Frames

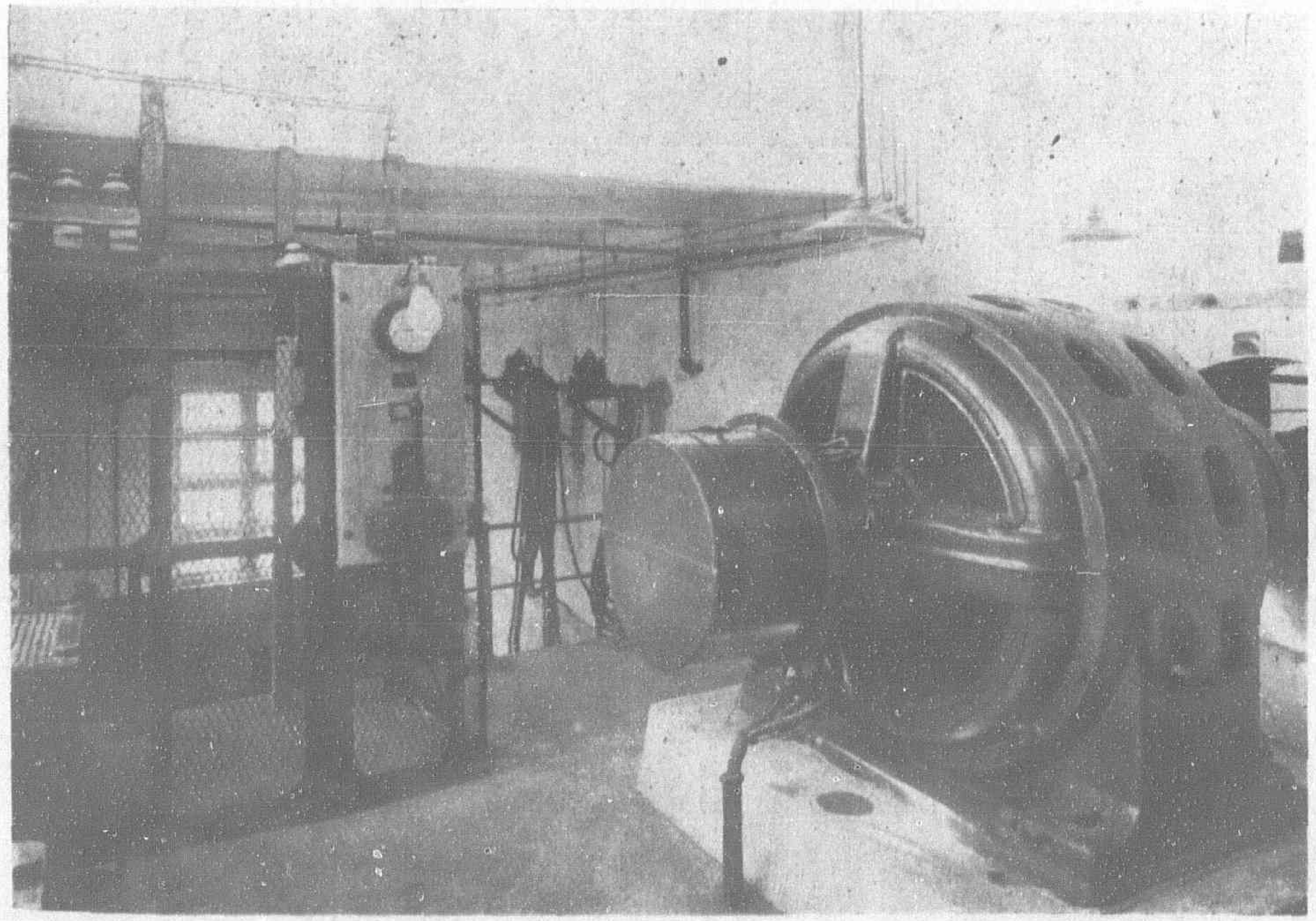
TYPICAL INDUSTRIAL POWER DRIVES IN SHANGHAI



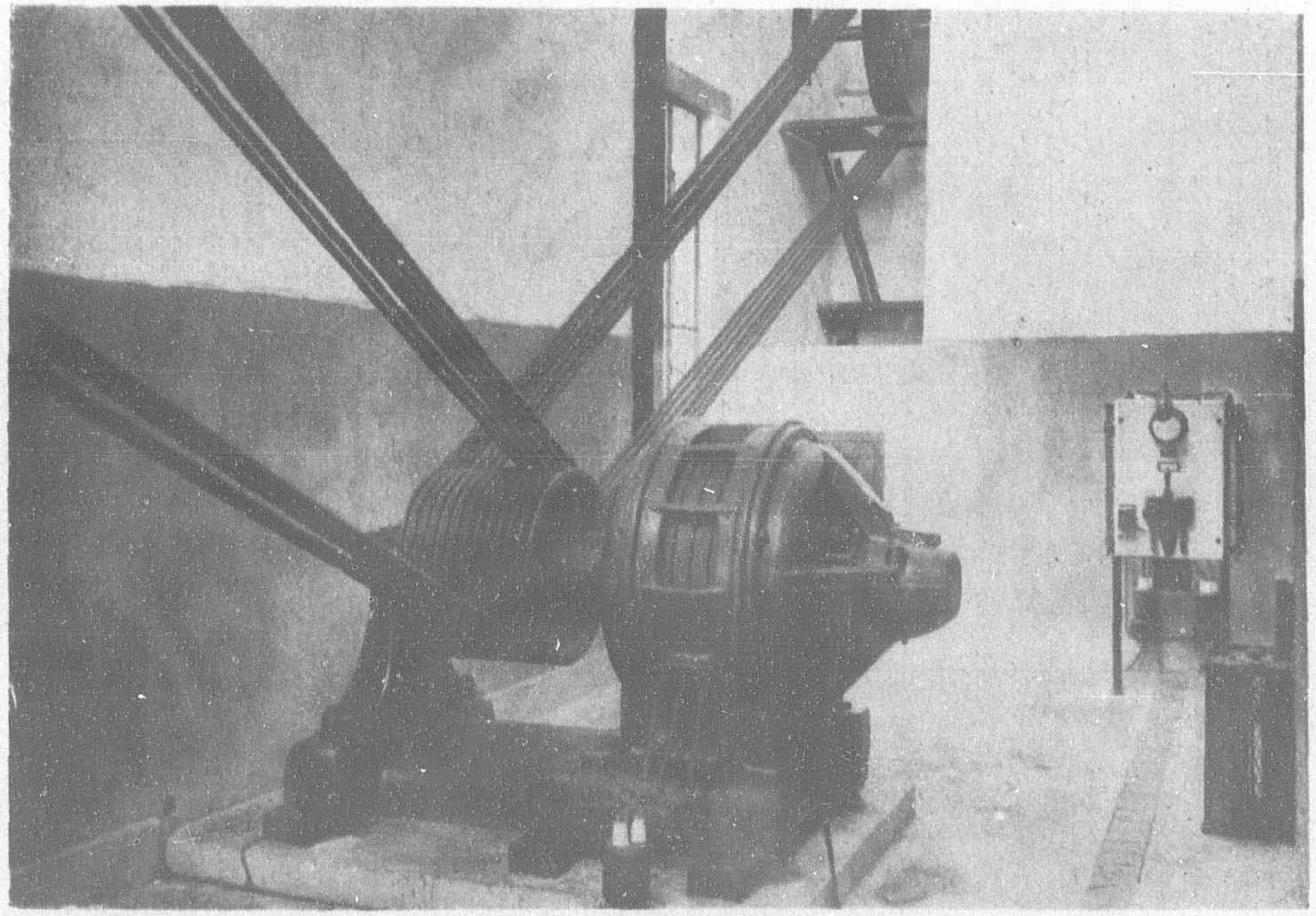
1,200 h.p. Motor Driving Flour Mill by means of two 42 inch Leather Belts



6,300 volt 400 h.p. Motor Driving Flour Mill



Direct Coupled 500 h.p. Motor Driving Flour Mill



Not Good Practice but shows what can be done in Emergency reduction of frequency and voltage due to system disturbances. Normally the running turbo set is kept floating with the system except under circumstances requiring load adjustment for feed water temperature regulation. The auxiliaries of all other units outside the 80,000 kw. mentioned are supplied through step-down transformers from the 22,000 volt sections.

Workshops.—The workshops are equipped for smiths and plate work, carpentry, machining and fitting work; also for the winding and testing of electrical machinery and apparatus. Repair work for all departments is catered for, and a certain amount of new work is also carried out.

Laboratory.—There is also a complete laboratory which is fully equipped for the analysis of coal, water, oil, paint, metal and other stores.

Notes on Plant Operation and Performance at "B" Station.—As previously mentioned, the new section, namely, "B" Station, is operated as base load plant, and the boilers are equipped with International Combustion Company's Lopulco bin and feeder system pulverized fuel apparatus. The deciding factor in adopting the pulverized fuel system was that this would open up a much wider field in the choice of fuel, in that certain available and relatively cheap grades of coal, which could not be handled efficiently by the existing mechanical stokers, could be utilized to advantage in powdered form, and it is gratifying to note that in operation subsequent to the usual minor adjustments the economy anticipated as a result of the departures in design referred to has been realized, this being mainly due to the higher efficiency obtained by operating at the higher steam pressure and temperature, the higher efficiency of the Metropolitan-Vickers multi-cylinder high speed turbo-alternators, and the high efficiency of the Stirling and Babcock boilers, with the pulverized fuel equipment mentioned above, burning comparatively low grade coals. This base load plant has not yet been in operation for a sufficient length of time to make direct or equitable comparisons with other base load stations operating under the same base load conditions, but a fair conception of the possibilities can be obtained from the records of performance subsequent to the plant going into full service, and under specified operating conditions which briefly are as follow:—During the first six months of 1930 over 160 million kilowatt-hours have been generated in this section, representing over 49 per cent of the total output. B.Th.U.s per unit generated were 14,390, representing a thermal efficiency of 23.7 per cent.

Distribution System.—The undertaking supplies the whole of the International Settlement, as described in the foregoing, and in addition gives bulk supply to the French Concession and to the Chinese territory north of the International Settlement, the latter amounts to roughly 9,000 kw.

Primary distribution is at 22,000 volt, 3-phase, 50 periods, all by underground cables to six primary substations varying in size from 9,000 kva. to 40,000 kva. each. In these substations the pressure is stepped down to 6,600 volts and distributed mainly by underground cables, and in the outlying districts by overhead lines to secondary distribution and consumers' substations. From the secondary distribution substations the 350/200 volt, 3-phase overhead network is fed by step-down transformers and underground low tension feeders, or by underground high tension radial feeders and pole transformers. Views of typical primary and secondary distribution substations and pole transformer are given.

Primary Substations.—Three of the primary substations—Yangchow, Fearon and Tonquin—are each equipped with three 12,600 kva. banks of transformers, concrete cubicle type 22,000 volt and 6,600 volt switchboards as described under "Generation." Voltage and power factor regulation is effected by the use of synchronous condensers of 3,600 and 6,000 kva. capacity. At two of the substations these condensers are utilized as the drives for traction generators. The Connaught Road substation, which has only recently been placed in commission, is equipped with four 7,500 kva. three-phase outdoor transformers, direct connection is made between these and the main 22,000 volt incoming feeders, cable and transformer being regarded as a unit with the provision of overload and balance protection, the 6,600 volt sides of the transformers are connected by underground cables to Reyrolles indoor type remote control metal-clad switchgear.

Secondary Substations.—These are equipped with either concrete cubicle or metal-clad type 6,600 volt and 350 volt switchgear, step-down transformers 6,600/350/200 volts, three-phase units are used, the standard sizes being 325, 625 and 10,000 kva. Where necessary induction voltage regulators are used, in all cases these regulators are connected between sections of the 6,600 volt bus-bars.

Underground Cables.—The 22,000 volt underground cables are all of .15 sq. in. or .2 sq. in. sectional area. The older cables are paper insulated three core split concentric belted type, lead covered and steel tape armored, laid direct in the ground, the more recent cables being of the H.S.L. type. All 6,600 volt cables are three-core paper insulated lead covered and armored and the standard sizes used are .025 sq. in., .1 sq. in., .2 sq. in. and .3 sq. in. The low tension cables are similar but with four cores of equal section, the standard sizes being .25 sq. in. and .4 sq. in.

Overhead Mains.—The l.t. networks and services to consumers are all overhead except in the case of the supply to large buildings where the load warrants an individual l.t. underground feeder or a substation fed from .1 sq. in. 6,600 volt ring mains. This network is mounted on square wood poles 10 in. by 10 in. standing in concrete bases. The phase spacing is 11 in. flat horizontal. The standard size of bare copper used is .15 sq. in., .2 sq. in. and .3 sq. in.; service wires are weatherproofed with compounded triple braiding. The 6,600 volt lines in the outlying districts are mounted on the top of the poles, the street lighting and the l.t. network being arranged underneath in the order given. The street lighting is all on the series constant current (7.5 ampere) system fed by 15 and 20 kw. regulators, practically all these mains are overhead and 1/8 s.w.g. bare and weatherproof cable is used.

The rapid growth of the system in Shanghai may be gathered by consideration of the large amount of plant that has been installed in the distribution system during the past ten years, and a tabular statement indicating the increase in cable laid during the past ten years or so will be seen here alongside.

Staff.—The company employs 3,000 Chinese and 80 Russian workmen in the capacity of coolies, artisans, clerks and junior draughtsmen, etc., supervised by a staff, as previously mentioned, predominantly British and numbering approximately 200. The organization is such that in addition to operation and maintenance, extension work is carried out by this staff both in regard to construction and design.

	At Dec. 31, 1919.	*During past 10 years.*	*Total to date. Miles.*
22,000 volt cable laid	33	168	201
6,600 volt cable laid	49	138	187
L.T. cable laid	10	40	50
Telephone and pilot cable laid ..	17	114	131
Total miles laid	109	460	560
Substations built and commissioned..	73	94	167
Number of pole transformers and outdoor transformer points	11	80	91
Number of transformers installed ..	182	244	426
Kva. of transformers	59,735	293,325	353,060
Route miles of L.T. overhead ..	—	—	458 miles
Route miles of 6,600 volt lines ..	—	—	28 miles
Route miles of public lighting circuits	—	—	448 miles
Total number of street lamps connected	3,706	4,844	8,550
Candle power of street lamps	355,280	583,274	938,554

Overhead Lines in Shanghai

By C. S. TAYLOR, Vice-President and General Manager

The Shanghai distribution system is confined to a comparatively small but densely loaded area. The primary distribution is by means of 22 kv. cables, all underground. Secondary distribution is at 6.3 kv., and the greater portion is by underground cable, but in the less crowded districts a portion is by overhead lines. The l.t. network, 350 volts, three-phase, four-wire (200 volts to neutral) is all overhead, supplied either from substations through underground .4 sq. in., four-core cables, or from pole transformers. The public lighting is on the constant current (or series) system, divided into 61 circuits each supplied by a separate 20 kw. regulating transformer having an output of 7½ amps. at up to approximately 2,600 volts. These transformers are grouped in seven substations located in different parts of the area.

Supply is given to large power consumers by underground cables either at 22 kv. or at 6.3 kv. Large office buildings, stores, apartment buildings, etc., are generally given a direct supply from 6.3 kv. underground *ring mains* laid for this purpose. Distribution substations are spaced on an average some 3,000 ft. apart and each feeds by means of l.t. underground cables that portion of the network within a radius of approximately 600 ft. The more distant portions of the network are fed by means of pole transformers, supplied by 6.3 kv. underground radial feeders from the nearest substation. These pole transformers are of either 125 or 225 kva. capacity and from 1 to 4 are connected solidly, without fuses or switch, to each radial feeder. Where only one or two transformers are on one radial feeder, the l.t. sides are connected straight to the network through a set of isolating links. Where more than two transformers are on one radial feeder, a l.t. automatic pole mounting oil switch is inserted to prevent too much disturbance in the event of a network fault. The l.t. network is divided into small isolated sections each fed by one (or in heavy districts by two) l.t. feeders or by one pole transformer.

Square, parallel, Oregon pine poles, planed and painted, are used. These are in three weights, *i.e.*, 8 in. by 8 in., 10 in. by 10 in., and 12 in. by 12 in. Poles are not planted directly in the ground, but carried in a base consisting of a reinforced concrete stub some 6 in. 6 in. long, of which 5 feet is set in the ground and having an angle iron cradle projecting from the top, which takes the lower part of the pole. On account of poor soil conditions, difficulty in providing stays, narrow footpaths and frequent corners and crossings, a short span length of approximately 100 feet has been adopted in order to obtain a reasonably compact and stiff construction. All circuits are carried on horizontal, angle iron crossarms bolted to the poles by clamping plates, no holes being drilled in the wood.

Single 6.3 kv., three-phase circuits are carried on three-pin, four-feet crossarms at the extreme tops of the poles, using pin insulators, the center one being raised on a small stool to carry the wire clear of the pole top. Two 6.3 kv. three-phase circuits are carried by using a two-pin, four feet crossarm at the top, and a four-pin six feet cross arm set two feet lower down. The majority of the 6.3 kv. circuits consist of 7/6 strand bare copper conductors (.2 sq. in.).

The public lighting circuits are carried on two, four or six pin crossarms placed two feet six inch below the 6.3 kv. circuits or, where there are none of the latter, at the top of the pole. Single strand, No. 8 bare copper conductor is used for these, except for the drop (or service) to lamp fixtures, etc., for which triple weatherproof braided wire is used. A small cheap shackle insulator, about three inches in height, is used for these circuits, bolted direct to the angle iron crossarm, without the use of any packing washers or locknuts. It proves very satisfactory and is cheaper and easier to handle than pin insulators.

The l.t. distributors are erected on four-pin, four feet crossarms, two feet six inch below the public lighting circuits. The section of the neutral is always kept the same as for the outer conductors. For suburban work a 7/8 in. strand bare copper conductor is normally used, while for the heavier loaded districts either a 7/6 or a 37/12 strand conductor is used as required. These conductors are carried on shackle insulators exactly as described for the public lighting conductors above, except that a slightly larger insulator is used (some four inches high) and even with the heavy 37/12 conductor are perfectly satisfactory, breakages being almost unknown.

Where 6.3 kv. circuits are run, 40 feet poles are normally used, these, in conjunction with the concrete base, giving a height of some 41 ft. 6 in. above ground level. The majority of the poles, where there are no h.t. lines, are 35 feet long, giving a height of 36 in. 6 in. above ground when erected.

Creosoted poles have not been used in Shanghai where it was feared that with the many narrow and crowded pavements, if the poles bled in the hot weather, there would be many complaints of damage to the white clothes of passers by.

An Oregon pine pole, with a tarred butt, planted directly in the soil has a life of from four to seven years. A concrete base, as described above, with the ironwork well painted, lasts some 12 years. We are now galvanizing all exposed ironwork and expect to get a life of over 20 years.

An untreated Oregon pine pole, standing in a base, develops rot in the bottom 8 or 12 in. after about seven years, but if the pole is lifted out and this portion is cut off, the pole is given a new lease of life. The poles are painted (Battleship Grey) for appearances only, as the paint adds little to their life. Shakes and cracks develop due to weathering in any case.

Stays consist of either 3 or 5 strand No. 8 galvanized steel wire. No insulators are used in stays, but care is taken to see that they are attached to the poles at least six inches clear of crossarms. No ground wire is used and all metal work on poles is left ungrounded except in the case of lever operated line switches and links. With 6.3 kv. line switches and links, double insulation is provided in the operating mechanism and the handle portion is grounded to earth stakes driven close to the foot of the pole.

The l.t. distributors are interrupted at least once in each block by the insertion of a so-called breaking bracket, *i.e.*, the cables are cut and dead-ended on two brackets fixed back to back on opposite sides of the pole. For the heavier cables each bracket consist of two angle iron crossarms, the top one inverted, with the shackle insulators bolted between.

Where necessary these form the isolating points between adjacent network sections, otherwise they are connected across by v.i.r. jumpers fitted with screwed clamps, thus providing means for ready disconnection.

At definite points between adjacent network sections, lever operated pole switches are connected across the breaking brackets, thus allowing means of quickly and easily feeding a section either in the event of failure to its normal supply or while carrying out maintenance work.

Owing to the large radius used at street intersections, it is practically impossible to use any form of corner pole, and instead the lines of both routes are carried straight through but so spaced that the circuits of one route cross the respective circuits of the other route with about one foot six inch clearance. At the crossing point the lines are connected by means of flying jumpers.

Pole transformers are mounted on a channel iron platform between two ferro-concrete poles, one short and one long. The 225 kva. transformer weighs some 2¼ tons and adding to this the weight of the poles, ironwork, etc., we get a total dead weight of some seven tons. To support this weight in the Shanghai soil, which consists of moist silt, a large reinforced concrete slab is placed at the bottom of the hole, this slab having two sockets in it to take the butts of the concrete poles. Two smaller reinforced slabs, on edge, are then bolted back to back, just below ground level and so as to clamp both poles between them.

In the more outlying districts if a pole transformer is required along the route of a 6.3 kv. overhead line, a similar set up is used, the transformer being fed through an underground cable, but this cable is tapped off the overhead line one span away, through a lever operated link switch and fuses, all mounted close to the top of the pole. This provides an accessible and not too congested an arrangement, keeps all exposed live metal well up the poles and the length of cable provides some lightning protection to the transformer. As these transformers are at times within reach of adjacent windows and balconies it is essential that there should be no exposed live metal about them.

In addition to the lever operated 6.3 kv. line links mentioned above, which are merely isolating links and mounted below the line they are tapped off, a lever operated, upward opening line switch is also used where required.

All lever operated line links, and switches, both h.t. and l.t. as well as the h.t. pole fuses are of the company's design and of local manufacture.

Lamps for public lighting are provided in 60, 100, 250, 400 and 1,000 c.p. sizes and either mounted on pole brackets or suspended over the roadway. The most popular size and type is a 250 c.p. lamp in a simple radial wave, dome reflector fitting, the latter suspended on a span wire over the roadway. Either one, two or three fittings are suspended on each span wire according to the width and importance of the roadway to be lighted.

Each public lighting circuit is equipped at about four points with a link arrangement which allows of the circuit sections on either side being either isolated or grounded. In the event of a fault due to an open circuit, it can generally be quickly localized to a section between links and isolated, and then by grounding the adjacent ends of the healthy portion of the circuit this can immediately be put into commission while the actual fault is being finally localized and repaired.

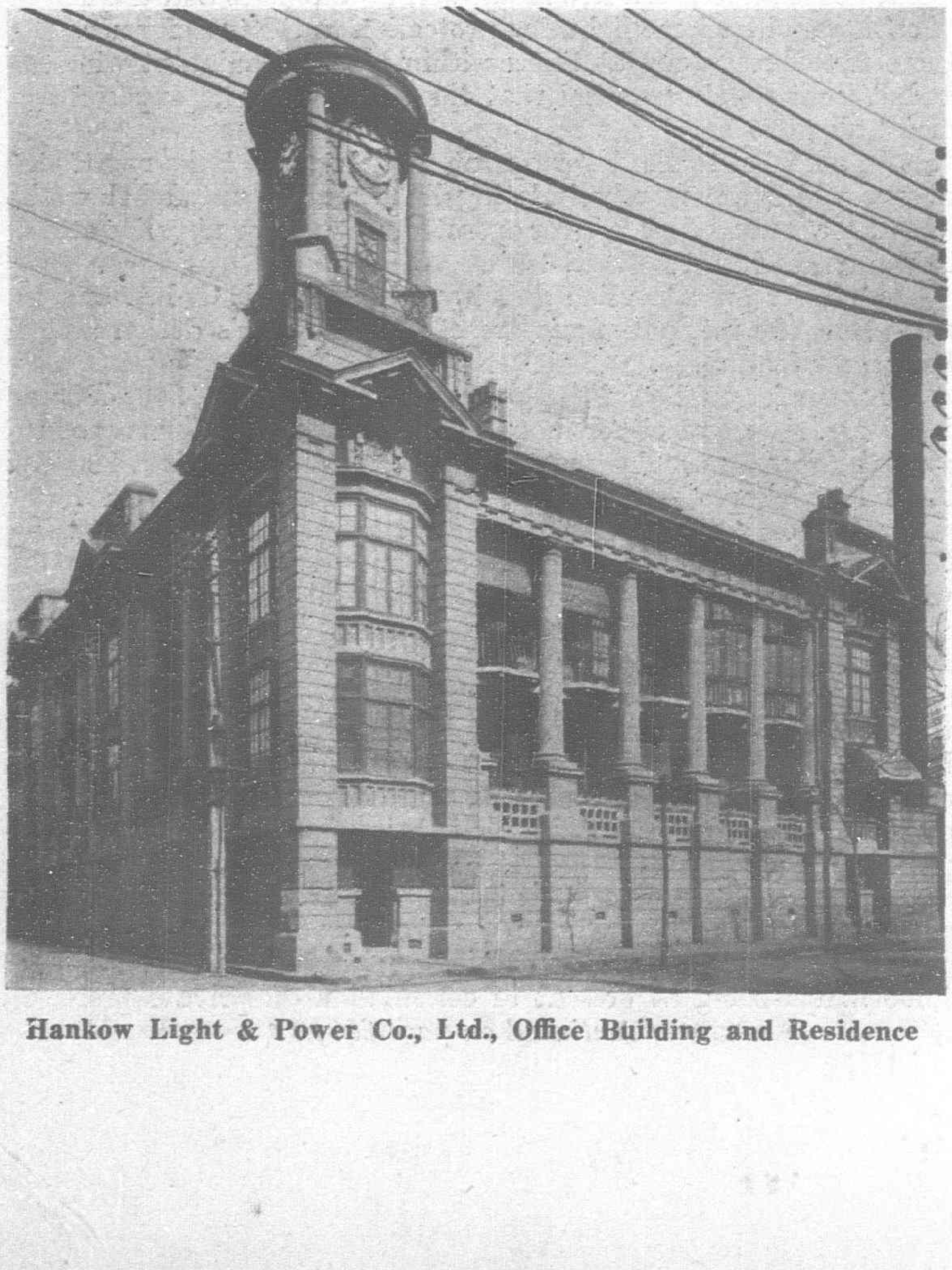
The street lighting system in addition to providing the public road lighting is also used for the lighting of private roadways, alleyways, and compounds. This service is very popular, over 4,600 lamps being at present in commission on private premises.

(Continued on page 306).

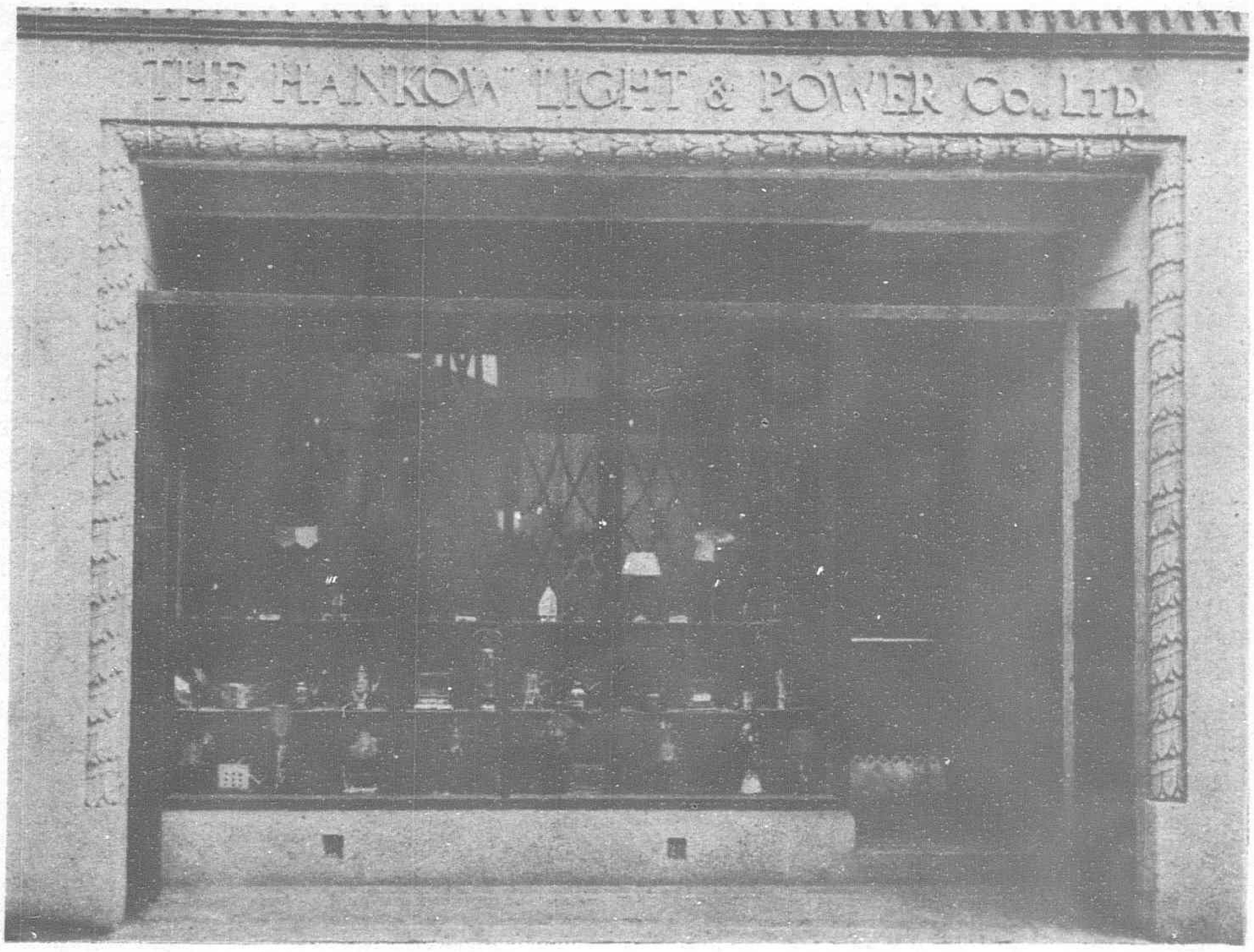
The Hankow Light and Power Co., Ltd.

1. History.—The Company was formed on May 21, 1905, as an offshoot of the then existing firm of Messrs. Poole, Lauder & Co. Fur Traders and General Merchants, and entered into an agreement with the British, French and Russian Municipal Councils conjointly to supply electricity to their Municipal Areas on November 26, 1905, for a period of 15 years. The franchise was renewed for a further period of 20 years from November 26, 1921, the new agreement comprising many improvements, modifications and alterations, being drawn up on May 21, 1920, exactly 15 years after the formation of the original company. During the early years of its life the Company went through many difficulties as it was forced in its infancy to shoulder the somewhat heavy burden of the debts of its parent, Messrs. Poole, Lauder & Co. who went into liquidation shortly after the signing of the first agreement with the Councils. These debts were redeemed by the issue of first mortgage debenture shares and these debentures were finally paid off in 1915. Since that time the Company has prospered steadily in spite of the many vicissitudes in the way of civil wars, etc. in the Yangtze Valley and has not only paid an average dividend of 23 per cent on the £10 Ordinary Shares and an equivalent amount on the Deferred Shares for many years, but has made an issue of £5 Preference Bonus Shares on three successive occasions to all holders of the original Ordinary and Deferred Shares. The capital of the Company at present stands is £80,100 made up as follows :—

8,000 7½% Cumulative Preference Shares of £5 each...	£40,000
4,000 8% Cumulative Second Preference Shares of £5 each	20,000
2,000 8% Cumulative Ordinary Shares of £10 each ...	20,000
2,000 Deferred Shares of 1/- each	100
	£80,100



Hankow Light & Power Co., Ltd., Office Building and Residence



Hankow Light & Power Co., Ltd., Show Window

During the troubles of 1927-8 the Company naturally suffered severe financial losses both by reason of military sabotage and the excessively high cost of production and they were therefore unable to declare a final dividend for a period of three years. All arrears of obligatory dividends have, however, now been paid and the Company was able to declare the usual final dividend of 30/- on the Deferred Shares and 15 per cent on the Ordinary Shares at the close of the last financial year.

The position with respect to the Chinese Municipal Authorities is at present somewhat vague. On several occasions since taking over the ex-German and ex-Russian Concessions they have manifested a desire to exercise a greater measure of control over and to interfere in the operation and management of the Company to such an extent as could not possibly be permitted. However, as the Company is still operating under the protection of Treaty Rights they have been able to obtain the assistance of His Majesty's Government in effectually resisting these attempts at interference and control, but there is no doubt that these efforts will be renewed and probably with greater success when the time comes that the British Government have followed to its ultimate conclusion their declared intention of relinquishing their extraterritorial rights.

2. Generating Plant.—The Company's generating plant consists entirely of Belliss & Morcom reciprocating engines, direct coupled to three wire shunt wound direct current generators. The entire supply is direct current at 450/500 volts, the supply voltage for lighting purposes being 220 volts. The following are the particulars of the generators :—

No.	*Full Load Rating*	*Type*	*Time of Purchase*
1, 2 and 3	125 kw.	2 cylinder simple expansion...	1905
4	300 kw.	2 cylinder compound V type	1911
5	400 kw.	2 cylinder compound V type	1915
6	1,000 kw.	Triple expansion	1920
7	1,000 kw.	Triple expansion	1924

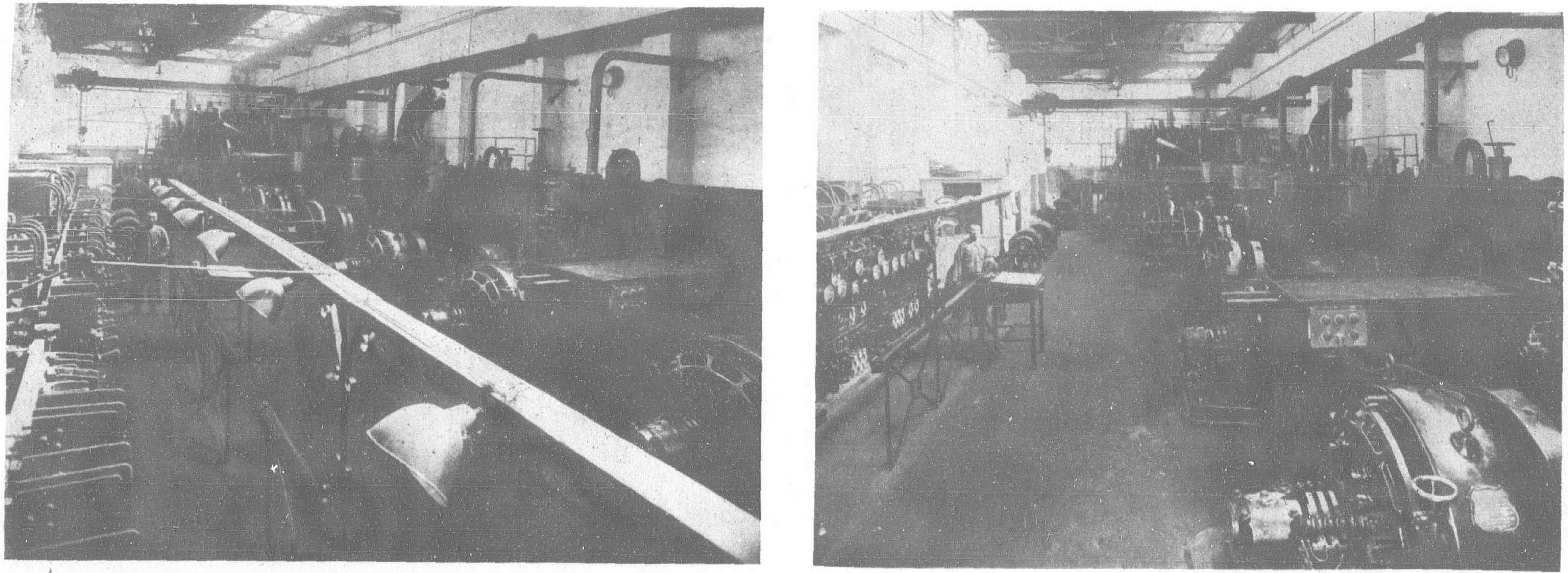
Note.—Numbers One to five engines ran non-condensing until 1924 when a large size condensing plant was installed with Number seven set. Number six set was supplied with its own condensing plant.

3. Switchboard.—The switchboard which is a simple three wire layout comprises 12 generator panels and 13 feeder panels complete with the usual switch and protection gear, the balancing being effected mechanically.

4. Boiler Plant.—The three original boilers which were supplied with the three original sets are each of 4,850 lb. per hour evaporating capacity and equipped with chain grate stokers. From time to time additional boilers have been purchased up to a total of

(Continued on page 314).

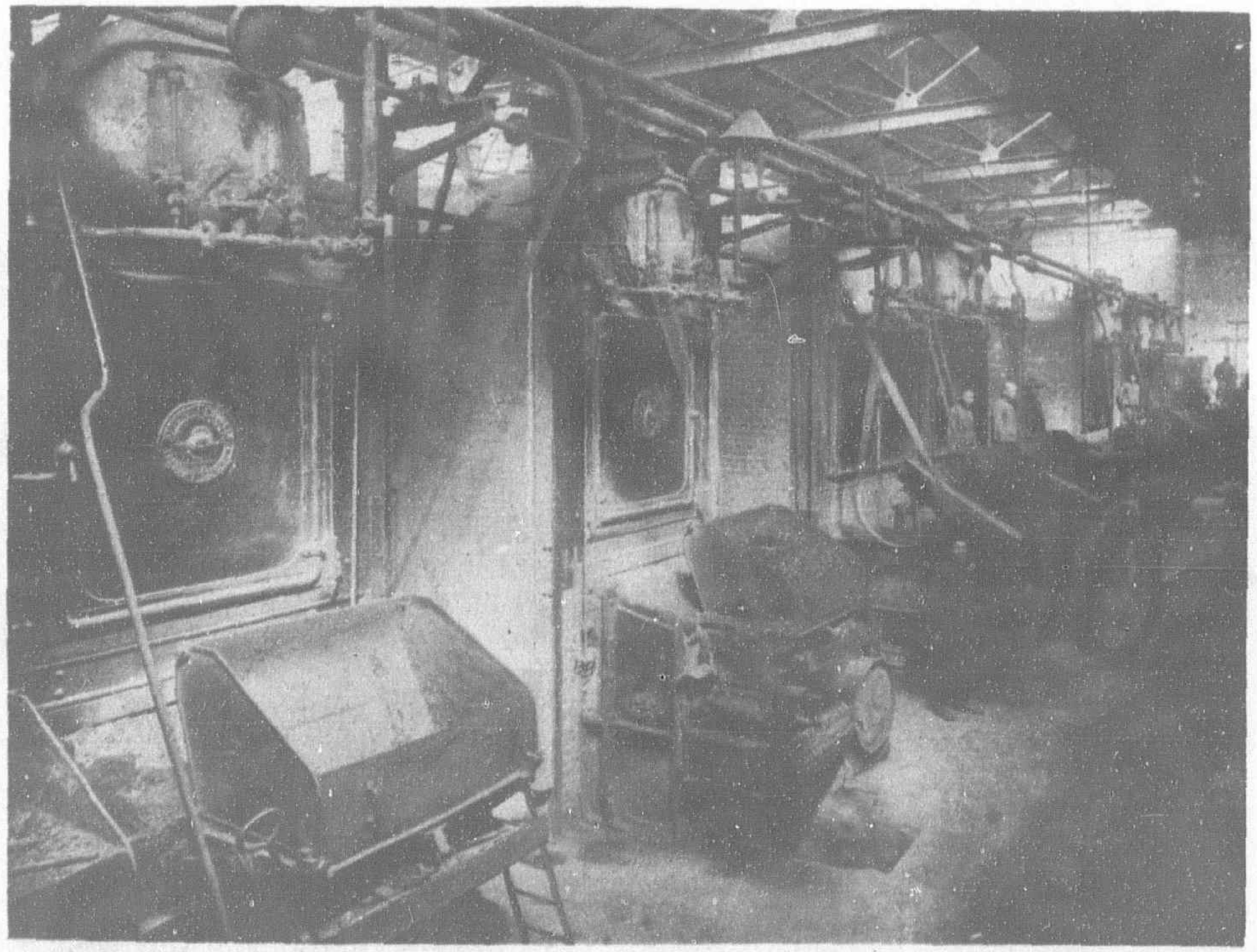
THE HANKOW POWER PLANT



1

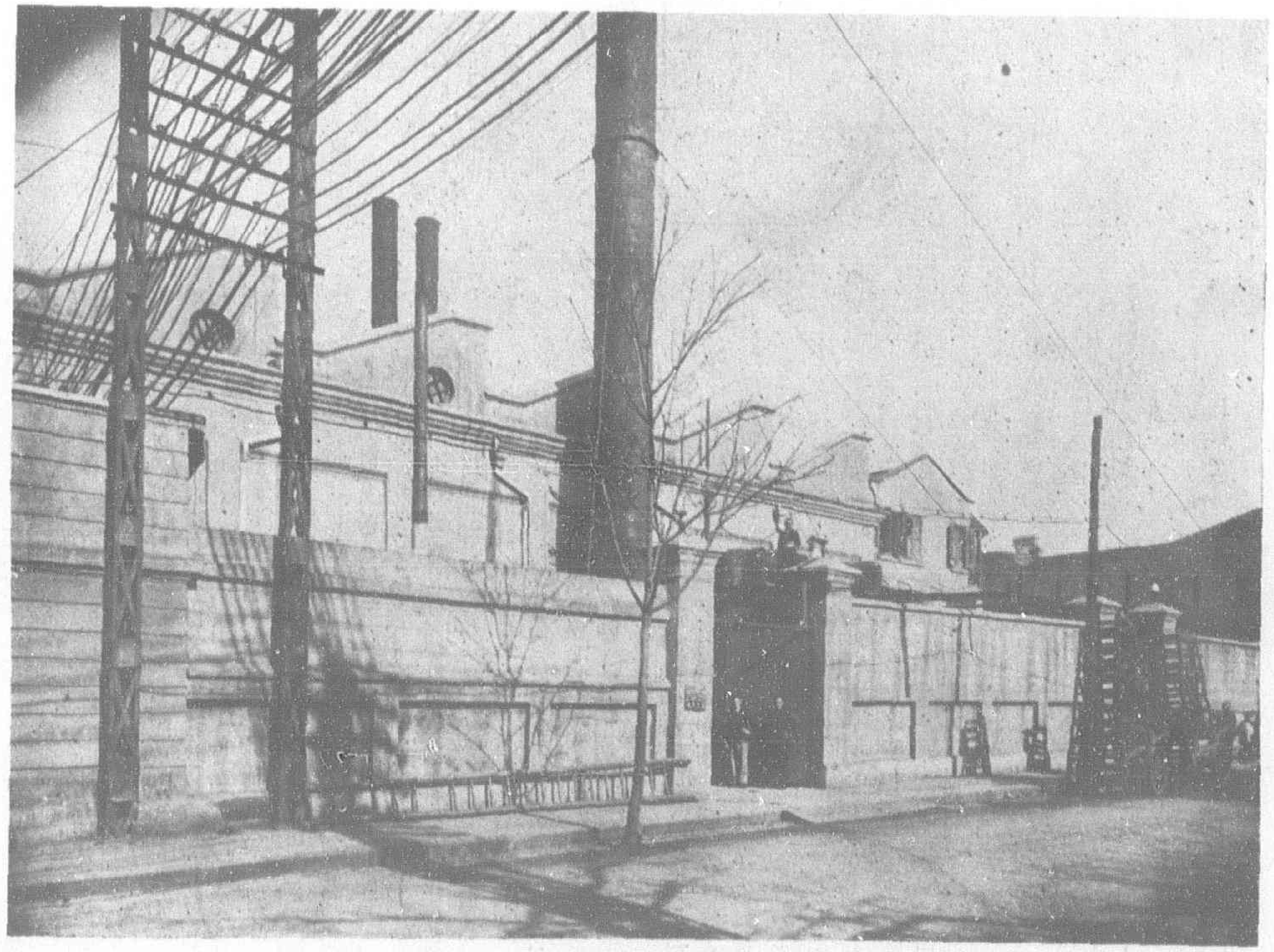
Interior of Generating Station

2



Boiler House

3



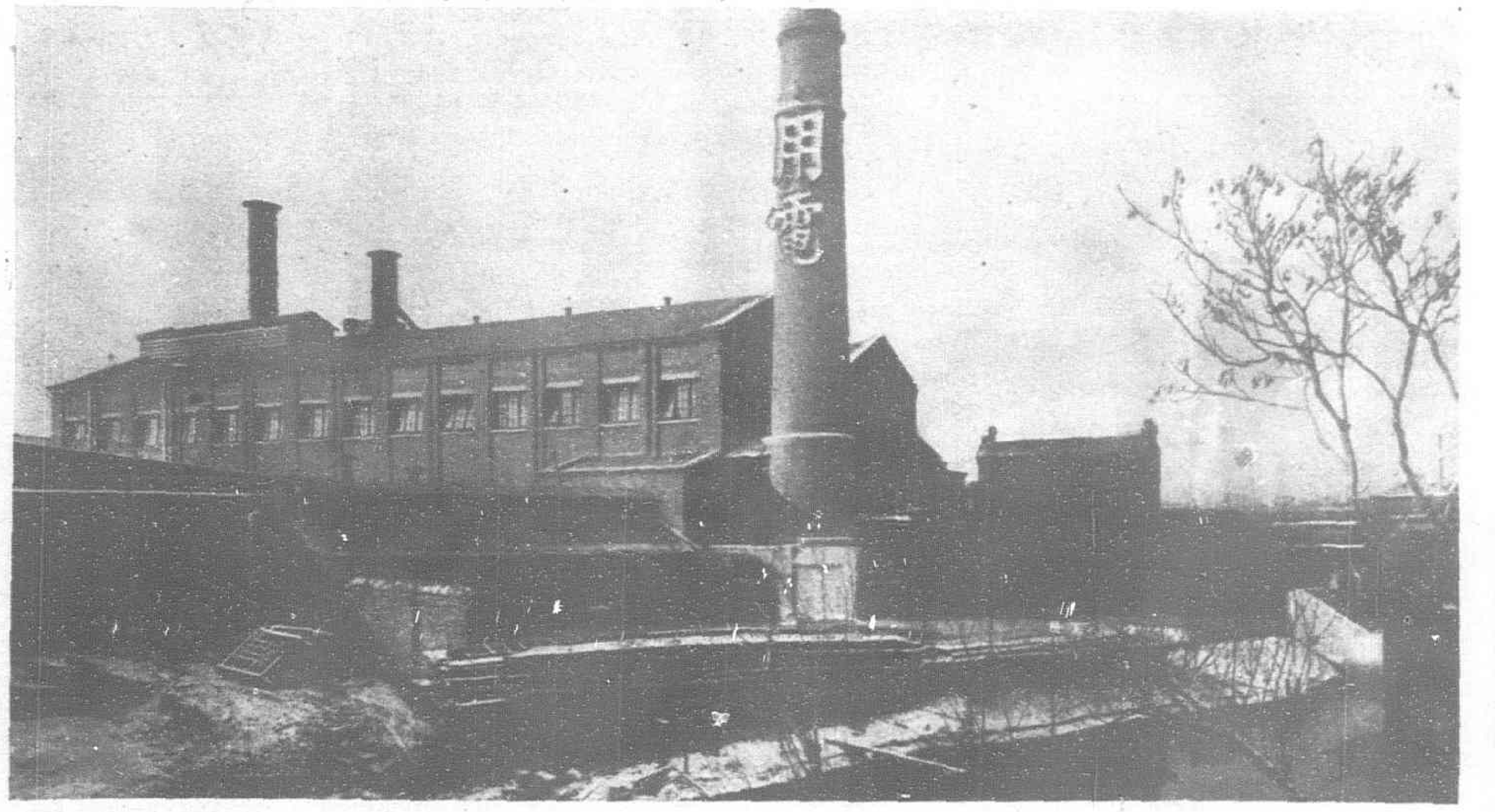
Entrance to Generating Station

4

The Electricity System of the British Municipal Council of Tientsin

Up to 1920, the supply of electricity to the British Municipal Concession in Tientsin had been given by a company that operated a direct current generating station; this had by this time become too small for the growing needs of the area and, on the expiration of the franchise that had been given many years before to the company, the Municipal Council decided to take over the supply of electricity and to erect a modern generating station and distributing system.

In April, 1920, the Council appointed Mr. R. A. Williams, M.C., B.Sc. as their electrical engineer and the Municipal Electricity Department has been under his charge from this date.



Exterior of Power Station. (The excellent smokeless character of the combustion will be noted)

Mr. Williams had been the consumers engineer in the Shanghai Electricity Department from 1910 up to his departure to the War and on this return, after a few months in Shanghai, he proceeded to Tientsin to organize the new venture.

It was decided to adopt the alternating current system of supply and, as the previous D.C. pressure was 220 volts, to use 220 volt single phase lighting and three phase 380 volts 50 cycles for power.

Owing to the complete change of the type of the supply of electricity it was impossible to utilize any of the old distribution wires and poles and an entirely new system had to be erected.

The new system of the transmission and distribution of electricity, like the old, was designed for overhead cables on concrete poles, which were adopted, in spite of their higher first cost, in order to keep the appearance of the streets and roads as tidy as possible and also because concrete poles in the long run are undoubtedly cheaper and more satisfactory than wood.

The whole of the new system had to be built up as rapidly as possible as it was imperative that it should be in operation before the winter; the difficulties of getting the work completed were very great, a new staff had to be trained and owing to the shortage of materials at the time, many articles, such as oil switches, had to be made locally.

In October, 1920, the new system was connected to the various residences in the area and a supply of electricity obtained temporarily from a neighboring power station.

In the meantime, plans had been made and contracts signed for the purchase of the boilers and turbo-generators of the new generating station as it was not possible to continue to purchase a bulk supply.

A site had been chosen previously for the station on the side of the Hwei Tze Creek, approximately in the center of the area, where a fairly good supply of circulating water was available.

The first plant ordered consisted of two Turbo Generators of Howden-G.E.C. manufacture of 1,000 to 1,250 kw. capacity 5,000 volts 50 cycles three phase; with steam conditions 200 lb. pressure and 595° F. temperature.

The machines and boilers arrived out in the early spring of 1922, the foundations were made as soon as the weather conditions allowed and by pressing on with day and night work the whole station was ready to work six months later, which constitutes nearly a record for speed in construction, all the more remarkable when it is considered that the labor available was of a very unskilled nature.

The first three boilers were of 2,852 sq. ft. surface and, like all the subsequent boilers, of Babcock & Wilcox manufacture, whilst the steam feed pumps were Weir's well known vertical type.

It had been thought that the new machines would be ample for the needs of the Concession for many years to come, but such was the demand for electricity that a new turbo-generator of 2,500 kw. capacity was found necessary and ordered from the Metropolitan-Vickers Company and erected two years later; again in 1927 another similar set was obtained from the same company.

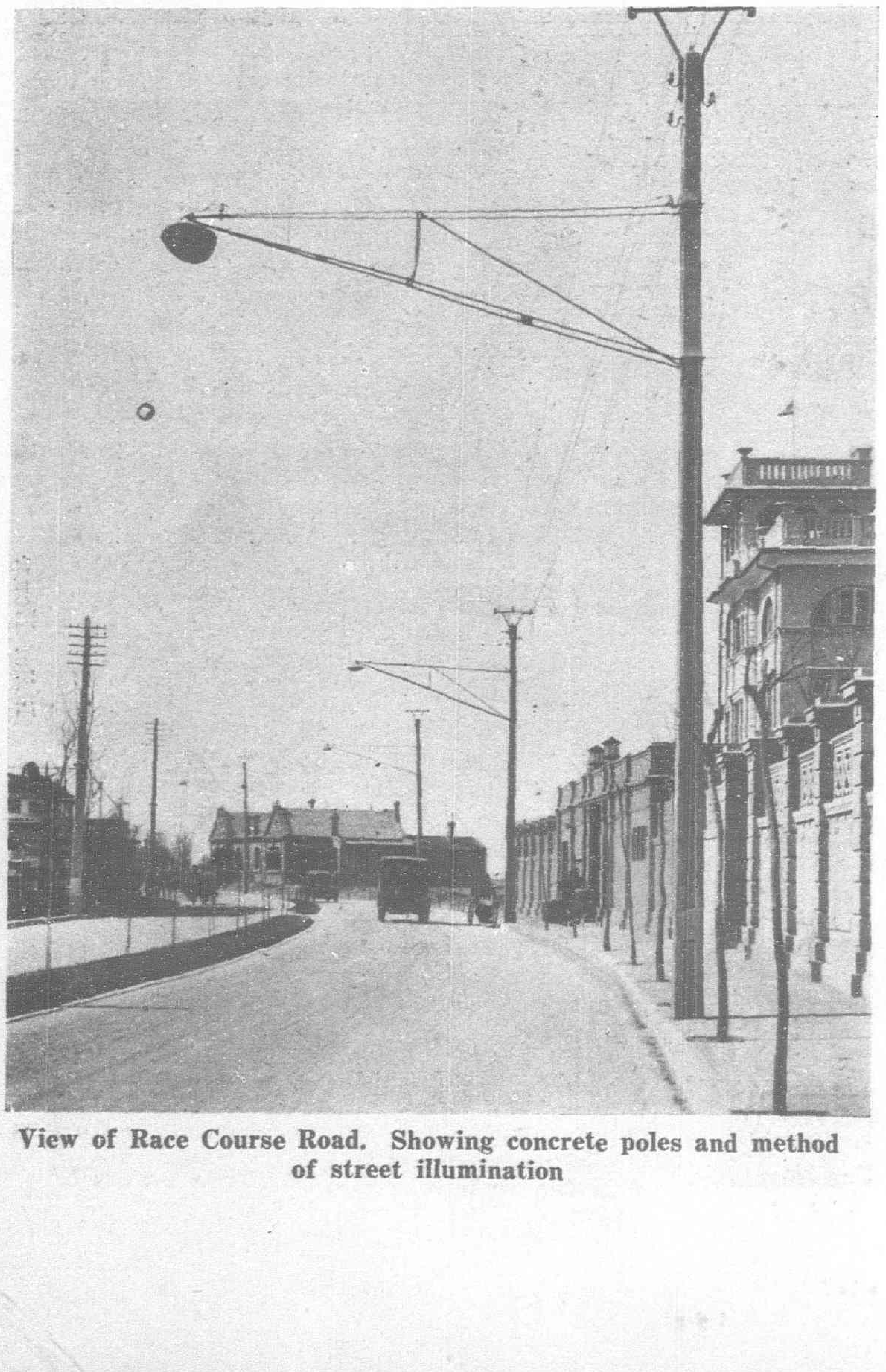
The present generating plant has a continuous capacity of 7,500 kw. consisting of two Howden-G.E.C. sets of 1,250 kw. and two Metropolitan-Vickers machines of 2,500 kw.

In order to keep up with the steam requirements of the turbines the boiler plant has been increased in size since the first installation in 1922; the first three boilers were each of a capacity of approximately 10,000 lb. of steam per hour.

The fourth boiler was similar to the other three but of double the capacity.

The fifth and sixth boilers were designed to be completely independent of all the other sets and have their own fans, flues, etc.; these sets are of Babcock & Wilcox's Marine type.

The total capacity of the boiler plant is now 130,000 lb. of steam per hour.



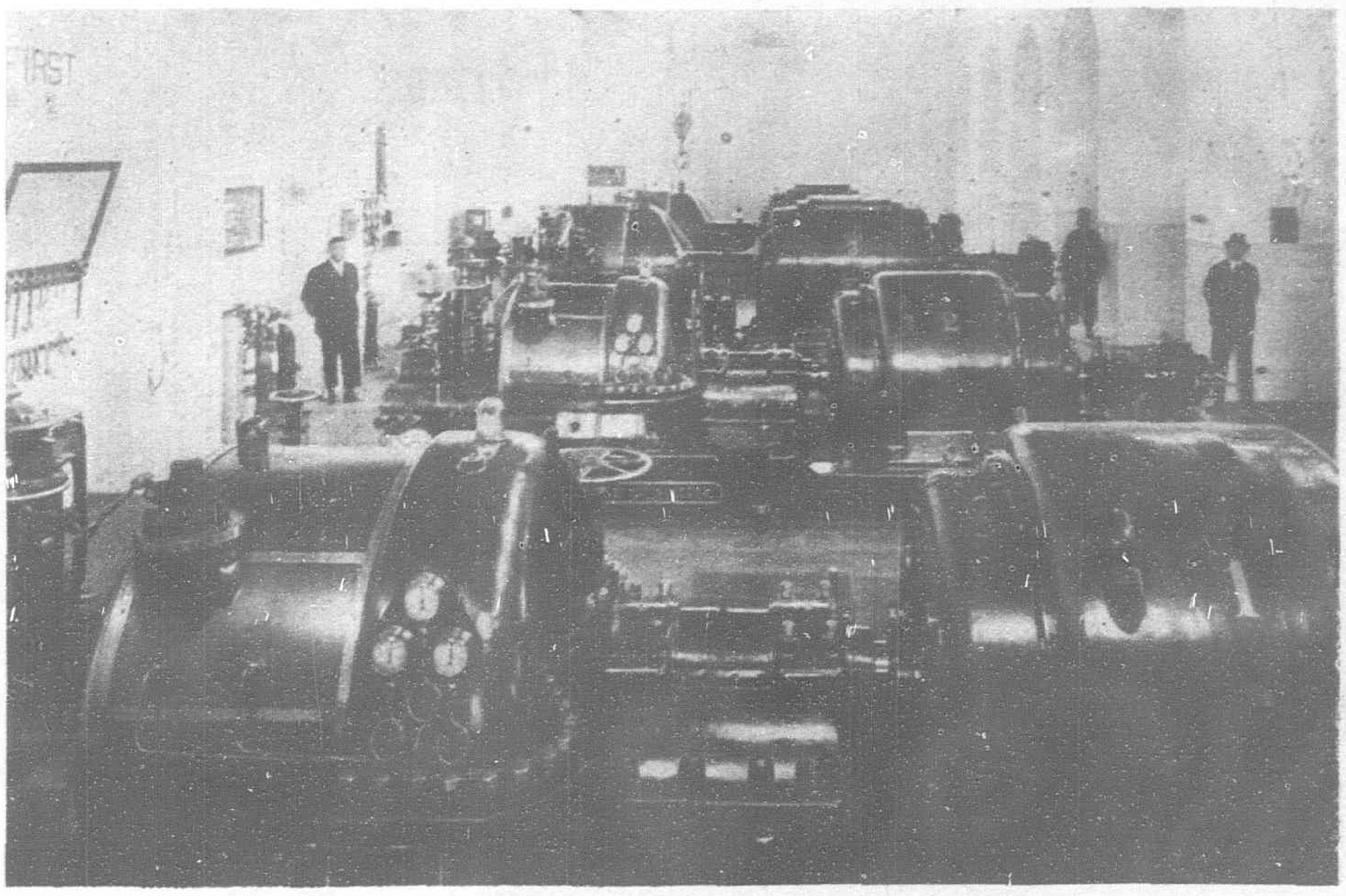
View of Race Course Road. Showing concrete poles and method of street illumination

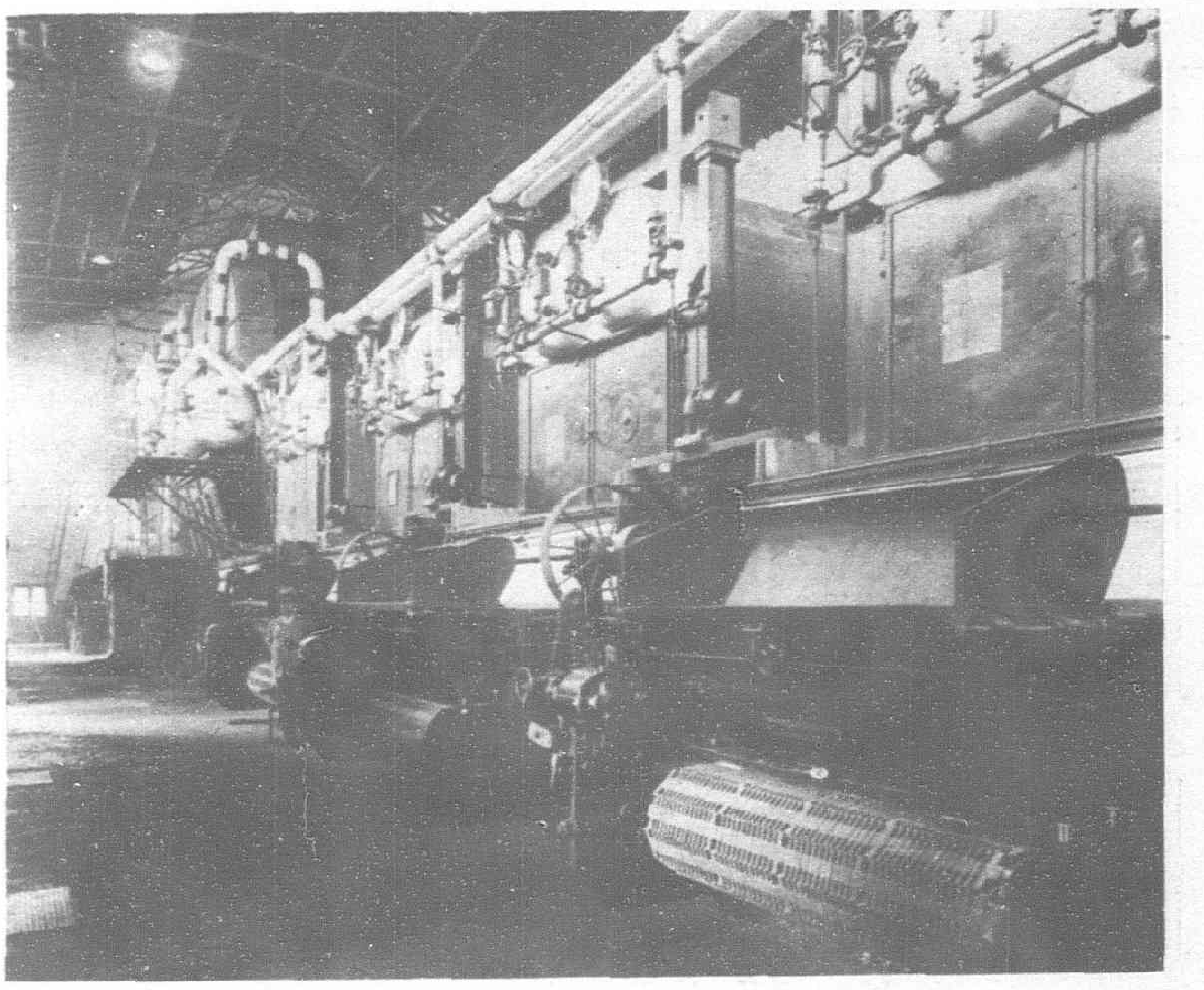
All the boilers are furnished with chain grate stokers.

In the original part of the boiler-house an economizer was installed to heat the feed water of the four "Land Type" boilers but with the two latter "Marine Type" sets air preheaters are used without economizers.

An original feature in the boiler-house is that the warm air from the alternator is pumped directly into the boiler that is on load, this helps to economize coal particularly in the winter when the outside temperature is very low.

The feed water is forced into the boilers by means of high speed electric pumps, the original steam feed-pumps are used only as emergency sets; the water level in the boilers is kept at a constant level by means of automatic valves, and generally it is to be noted that simple automatic machinery is largely used throughout the system, not so much to reduce labor, as much as to obviate the danger of accidents due to mistakes of the attendants.


Turbine Room


Boiler House Showing six B. & W. Boilers

The design of a comparatively small station such as this is in many respects different from a larger one as more care has to be taken to keep down the capital costs, which have to take second place to running costs which are all important in stations having large industrial loads and a good load factor; it is difficult to compare the capital costs of systems on different basis of gold and silver but it is noteworthy that the capital cost of the Tientsin Generating Station is Tls. 116. per kilowatt, which is considerably lower than recorded in any other system.

The generating station is maintained in an exceptionally clean and even polished state and indeed cleanliness is insisted upon as the first condition of good maintenance.

As stated previously the transmission pressure is 5,000 volts and the distribution of electricity is carried out entirely on the overhead system. Following the example of the station, the substations have been designed for extreme simplicity combined with the highest reliability and it is interesting to find that, in eleven years of working, not a single case of failure due to a transformer has ever been reported, which is a striking tribute to the Johnson & Phillips transformers which are used.

The district is essentially of a business or residential nature with no factories of any size; at first the total power load connected was only of about 10 kilowatts whilst today, such has been the effect of cheap electric power, that no less than 3,270 kw. is connected up in motors alone as compared with 10 kw. less than eleven years ago; the connections of electric cookers and heaters have also shown the same remarkable progress, which is illustrated also by the fact that the total amount of electricity sold in December, 1920, was 89,000 units as compared with 861,000 in December, 1930.

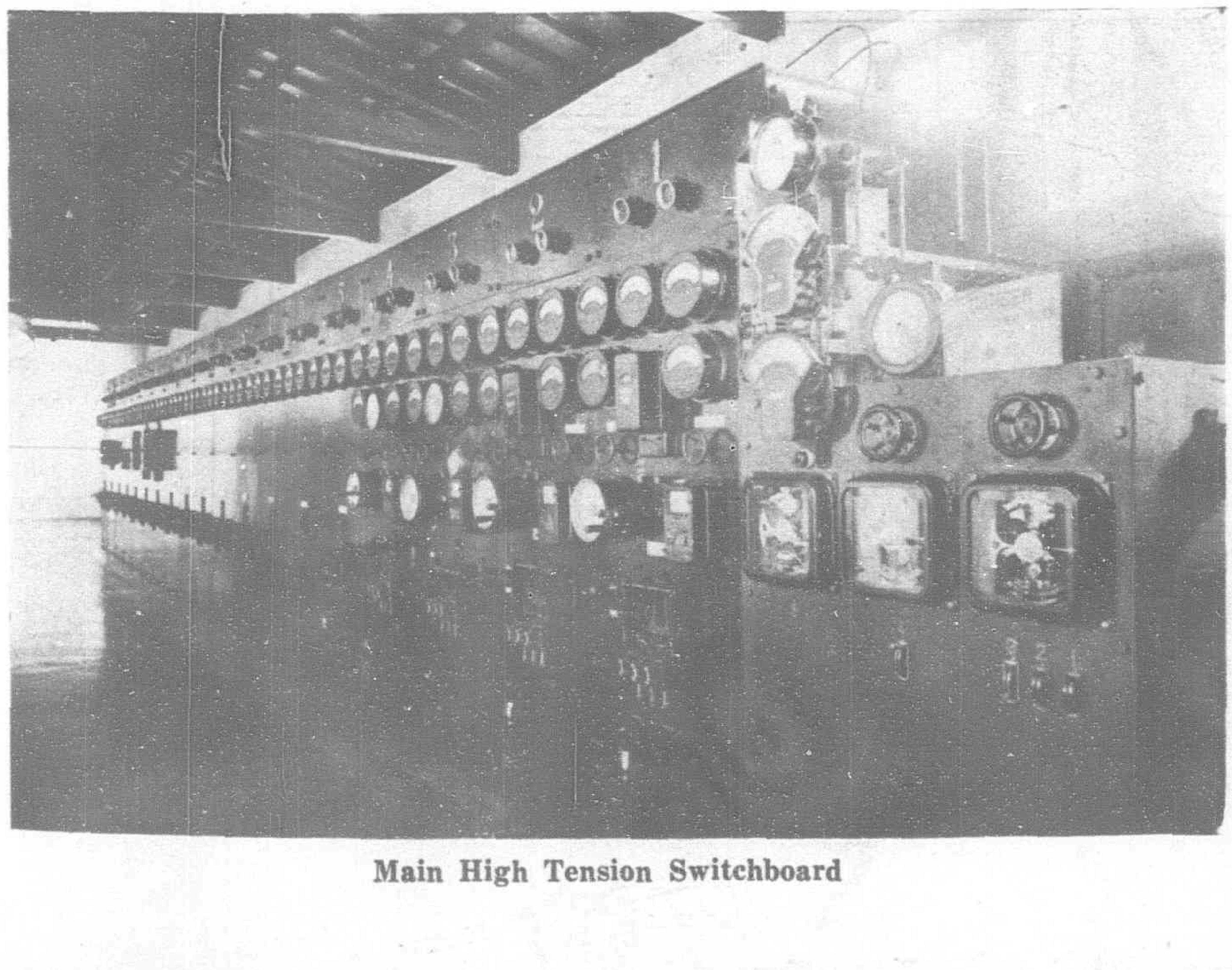
The photographs show the interior and exterior of the power station and particular attention is drawn to the smokeless combustion that is obtained.

The department maintains a very fine showroom in which electric appliances are demonstrated and sold to the consumers of the area.

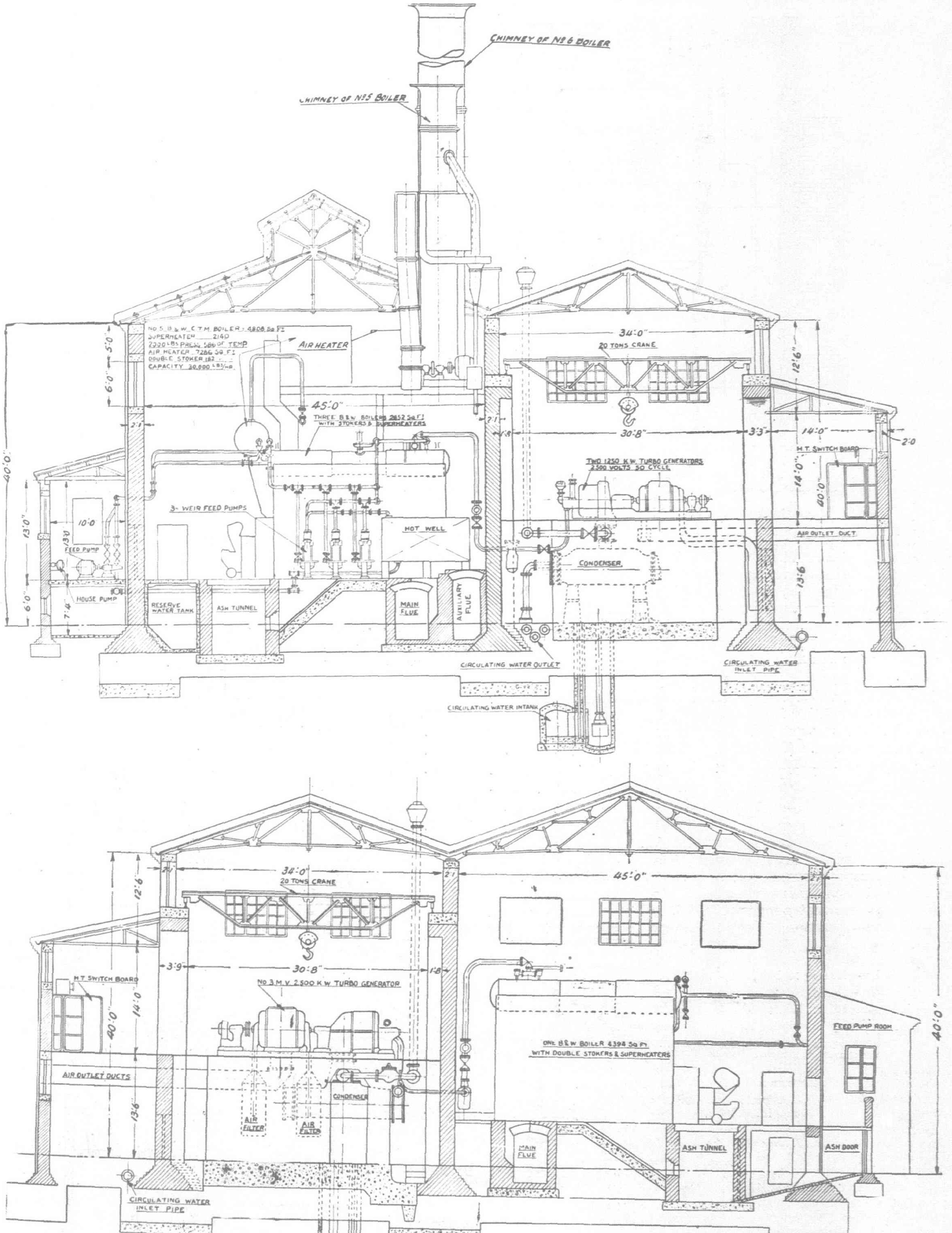
The street lighting of the British area has been very carefully designed; the lamps are held at very much greater heights, than is usual, above the street level which results is glareless but even illumination at road level.

The lamps are all operated on the "parallel" (220 volt) system which is considered to be superior to the "series" system adopted in some districts.

The electricity system is (with the exception of a few instruments) entirely British in design, manufacture and supervision and forms a remarkable tribute to the excellence of British plant.


Main High Tension Switchboard

Tientsin B.M.C. Power Plant: Plan



Tientsin B.M.C. Power Plant: Top-Section through A-B; Bottom; Section C-D.

Interior of Showroom

An Exhibition Electric Kitchen

Overhead Lines in Shanghai

(Continued from page 299).

When a loop for private lighting is taken off a main circuit it is usual to interpose a small one to one pole transformer and cut out. This has the double advantage of preventing a fault on the loop affecting the main circuit, as well as obviating the danger of taking a 2,000 volt line into the narrow and congested alleyways which are the principal consumers for this service. The company has a flat rate schedule for series lighting, covering cost of erection, supply of current and maintenance and based on the c.p. and type of fixture.

For example, a 60 c.p. lamp on a short bracket, the most popular type for private lighting is charged at £2 3s. 7d. per annum while 2—250 c.p. lamps suspended over the roadway are charged at £11 5s. 5d. per annum. (Say 9s. 6d. per month per 250 c.p. lamp).

Set out below are representative costs for materials and construction converted to sterling at present exchange rates. Construction costs include labor, supervision and transport, but no overhead charges.

While the rate of exchange of the Tael does not affect the quoted sterling price of material bought on a gold basis, or shipping, duty and insurance charges thereon, it does affect the conversion of all labor and local transport charges, etc. The present rate of exchange, is somewhat abnormal and therefore the costs quoted herewith should perhaps be increased some 10 per cent to allow for this.

	£	s.	d
Concrete pole base for 10″ × 10″ pole	1	5	6
Oregon pine pole—10″ × 10″ × 35′	1	7	6
Oregon pine pole—10″ × 10″ × 40′	1	13	3
L. T. lever operated pole switch	17	2	6
H. T. lever operated pole switch	15	6	6
Pole transformer structure erected complete, including concrete poles, ironwork, isolating links and connections, but excluding cost of transformer and underground cable ..	27	14	0
Average total cost per pole transformer, including 225 kva. transformer, 800′ .025 sq. in. 6.3 kv. armored cable, and half cost of H.T. switch panel in substation	350	0	0
Cost per mile for 4-wire L.T. only on 35′ × 10″ × 10″ poles using $\frac{7}{8}$ conductor (0.14 sq. in.), including pole bases, erection and average reinstatement cost	465	0	0
Cost per mile as above, using 37/12 conductor (0.3 sq. in.) ..	774	0	0
Cost per mile for one 3-phase 6.3 kv. circuit only on 35 × 10″ × 10″ poles using 7/6 conductor (0.2 sq. in.), including pole bases, erection and average reinstatement cost	482	0	0
Cost per mile for one 3-phase 6.3 k.v. circuit using 7/6 conductor and L.T.—4-wire using 37/12 conductor on 35′ × 10″ × 10″ poles, including bases, erection and average reinstatement cost	1,100	0	0
Additional cost per mile per single wire public lighting circuit, excluding costs of fixture and services to same	19	0	0
Average cost of one 250 c.p. suspended lamp for public lighting, including cost of extra 10″ × 10″ × 30′ pole and base, span wires, fixture and service	3	0	3

Electricity Supply Scheme for the Province of Kwangtung, Portuguese Colony of Macao and the British Crown Colony of Hongkong

(Continued from page 286)

3. At or near principal load centers.
4. Suitable space for proposed plant and future extensions.
5. On direct route adjacent to railway between Hongkong and Canton.

Selection of 132,000 volts was made after consideration of :—

1. This voltage is extensively used in Australia, Brazil, England, France, India, Italy, Scotland, South Africa, Spain, Sweden and the United States of America.
2. Capital expenditure required compared with other voltages in relation to the line capacity and the loads to be carried.
3. Transformers, switchgear and other equipment suitable for this voltage is of standard manufacture in several countries.

The question of frequency is somewhat controversial. American practice favors 60 cycles, European 50 cycles.

Selection of frequency is based on the following considerations :

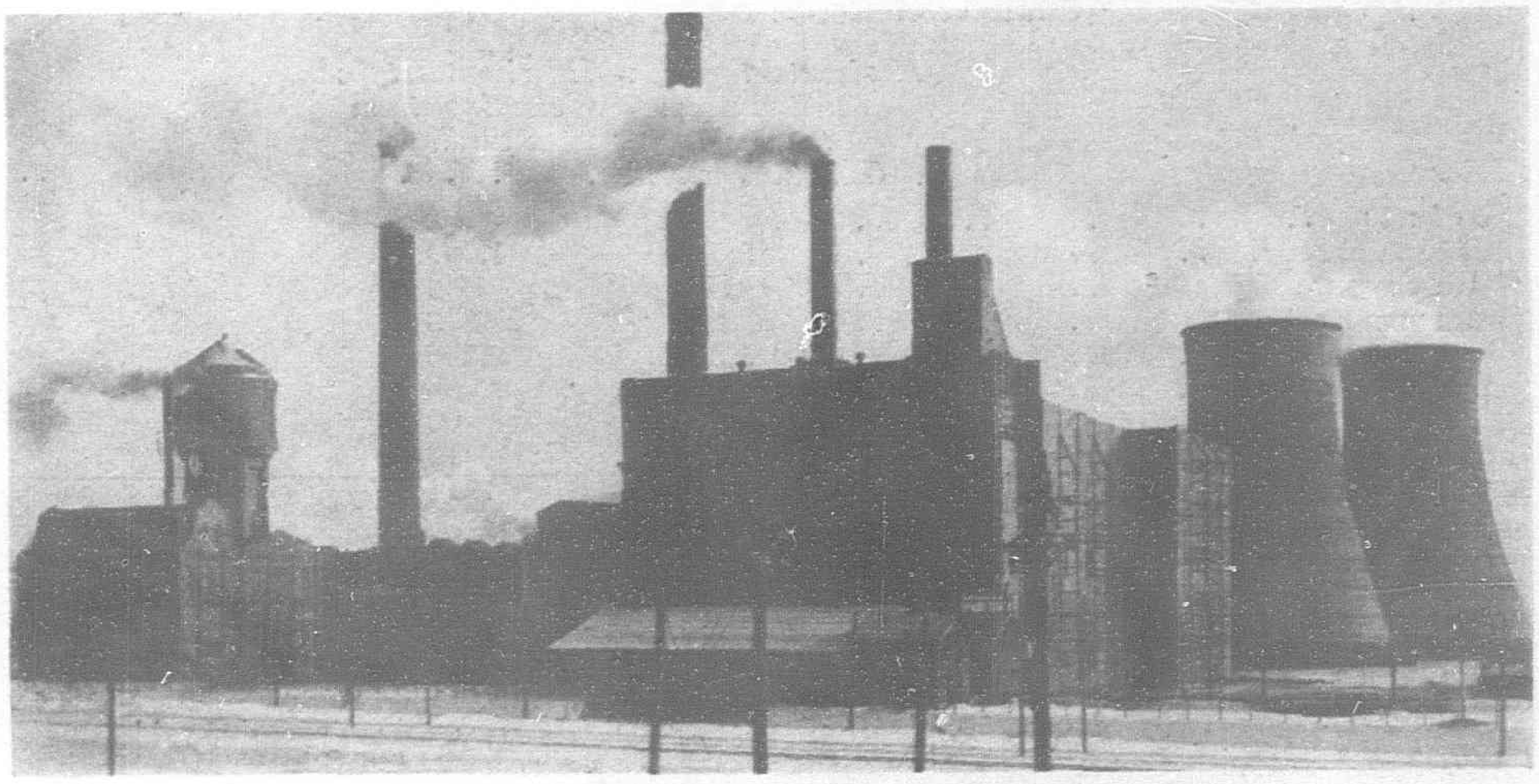
1. The load will be largely lighting and small power.
2. Seventy-five per cent of the installed capacity within the area operates at 60 cycles.
3. Practice in the United States of America and South American countries tends toward 60 cycles.

The problem of secondary distribution is somewhat distinct from the transmission system. It is mentioned briefly to show the added investment. American and European practice are widely divergent. Load, in Chinese cities comprises mixed lighting and small power within the same area.

The net-work system of distribution which is coming into universal practice in the United States is particularly adaptable to this kind of load. Providing 120 volts for lighting and 208 for power.

Electric Power Development in Fushun

By Y. OKA, Electrical Engineer



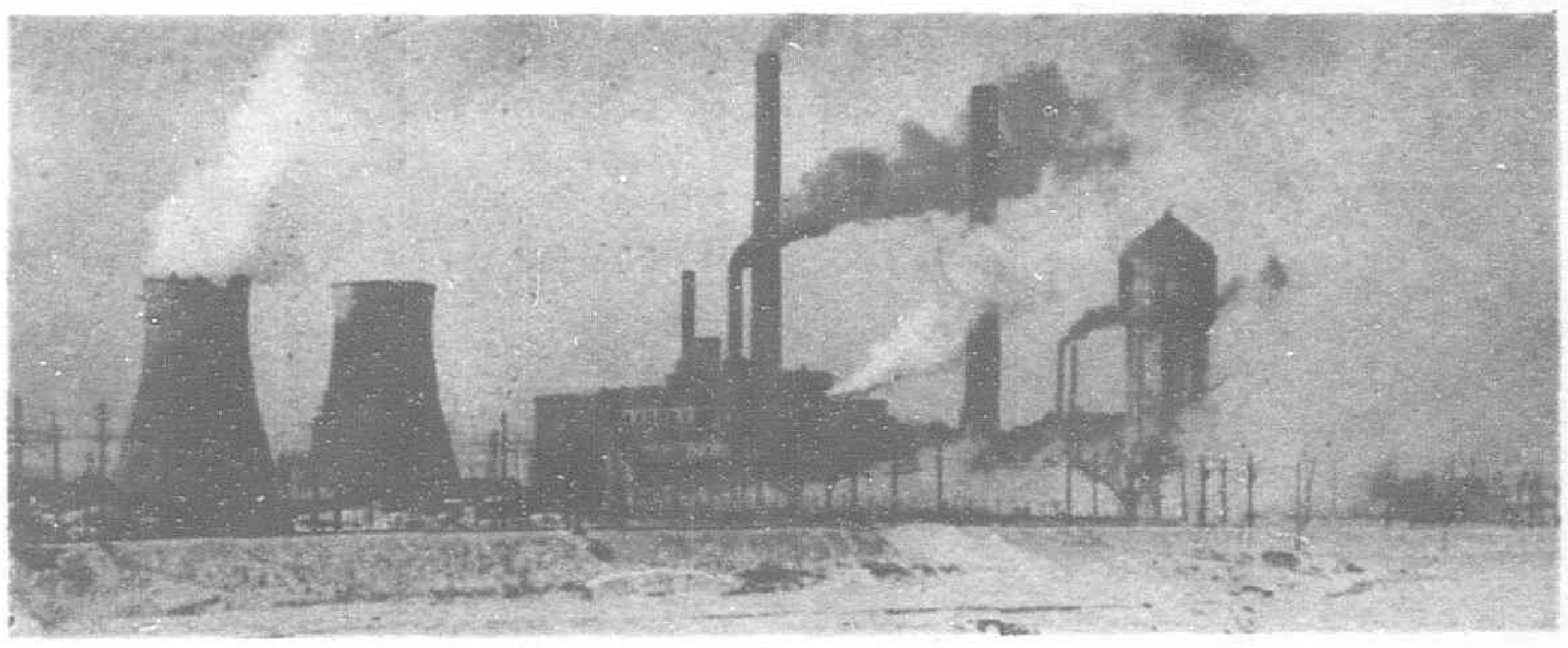
Taikanton No. 1 and No. 2 Power Stations, from North

THE output of electric power in Fushun has increased very rapidly and widely since 1908, when the mine was opened, as can be seen from the following figures:

1908	170,426 kw.h.
1910	2,535,123 ,,
1912	7,109,539 ,,
1914	14,560,149 ,,
1916	34,144,616 ,,
1918	67,829,704 ,,
1920	59,537,961 ,,
1922	64,047,185 ,,
1924	91,126,516 ,,
1926	122,121,997 ,,
1928	153,861,410 ,,
1930	190,650,000 ,,

Power Stations

The Fushun mines now operate three power stations: known as the Mond gas and the Taikanton No. 1 and No. 2, having an aggregate rated capacity of 67,000 kw. A new 2,500 kw. turbo-generator set is being erected in the Taikanton No. 2 station, and when completed, the Mond gas plant (2 by 1,500 kw., 3 by 3,000 kw., and one 1,200 kw.,) will be discontinued.



Taikanton No. 1 and No. 2 Station, from East

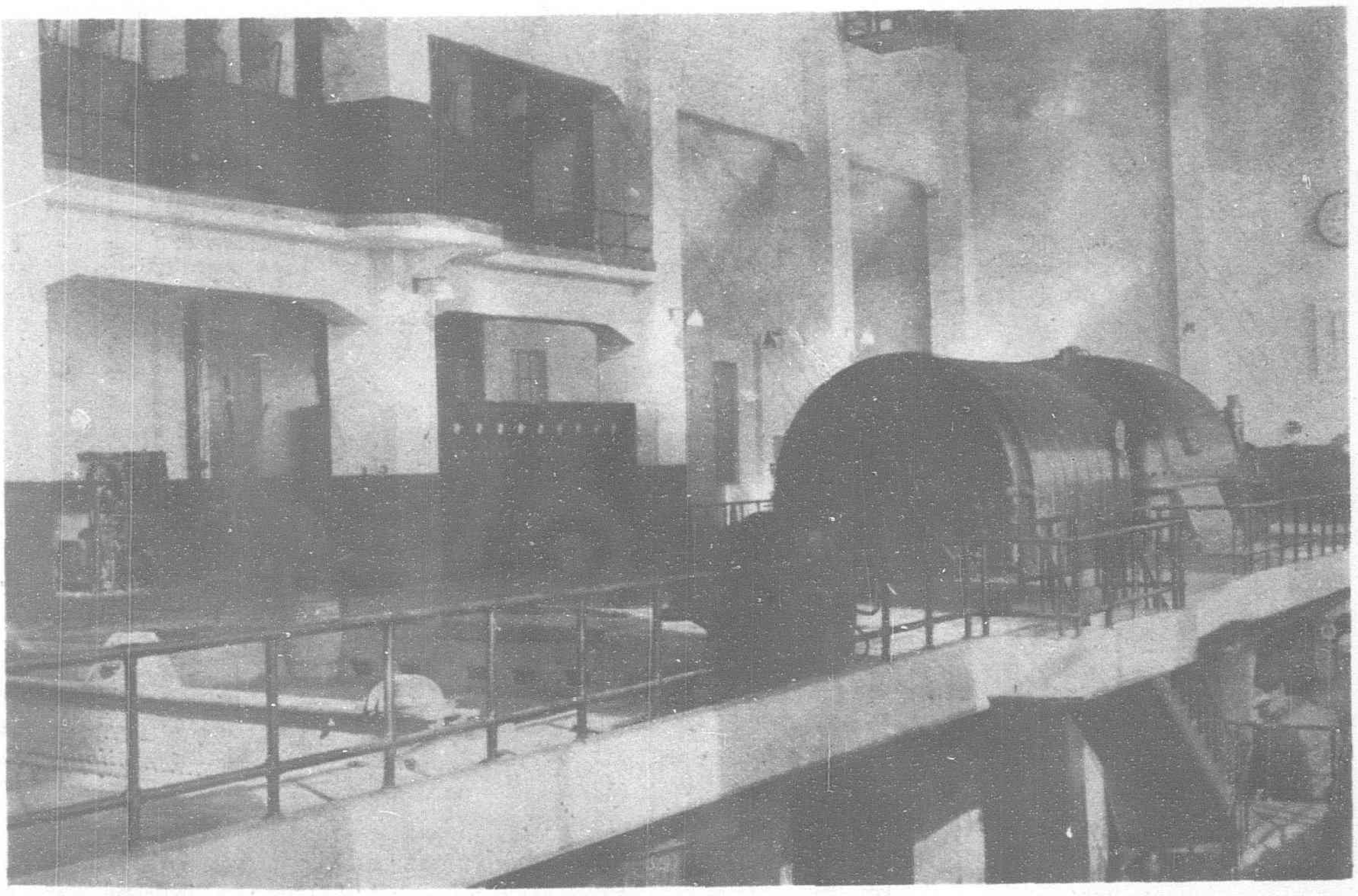
THE MOND GAS POWER STATION

The Mond gas power station was installed during the period 1913-1918, utilizing inferior hard coal of about 4,000-5,400 calories and 30-50 per cent ash content. The gas plant is divided into three banks; two are of the Mond's system bye-product recovery type and one is Lynn's bye-product recovery type with a coal consumption of about 740 tons per day for the three plants. Each bank includes a complete tar and ammonia recovery apparatus; gas washer, ammonia absorber, first and second coolers, gas governor, air blowers, gas exhausters, heat exchanger and other necessary accessories.

The tar produced is sent to the fractional distillation plant to recover creosote, hard pitch and a solution of sulphate ammonia which is pumped up to the vacuum evaporator and the centrifugal drier. These products are exported to Japan and other Oriental markets.

Gas is now piped to the boiler house at about 12 cm. of water column pressure to burn in the furnaces as a fuel, but after closing down the Mond power plant, the gas will be transmitted to the Taikanton station through a high pressure main of about on km. in length.

In the winter season, about 10 per cent of the total gas output is supplied to isolated boilers in the public buildings in the city of Fushun for heating purposes.



25,000 kw. Generator, Taikanton No. 2 Station

MOND GAS POWER HOUSE EQUIPMENT

BOILER ROOM

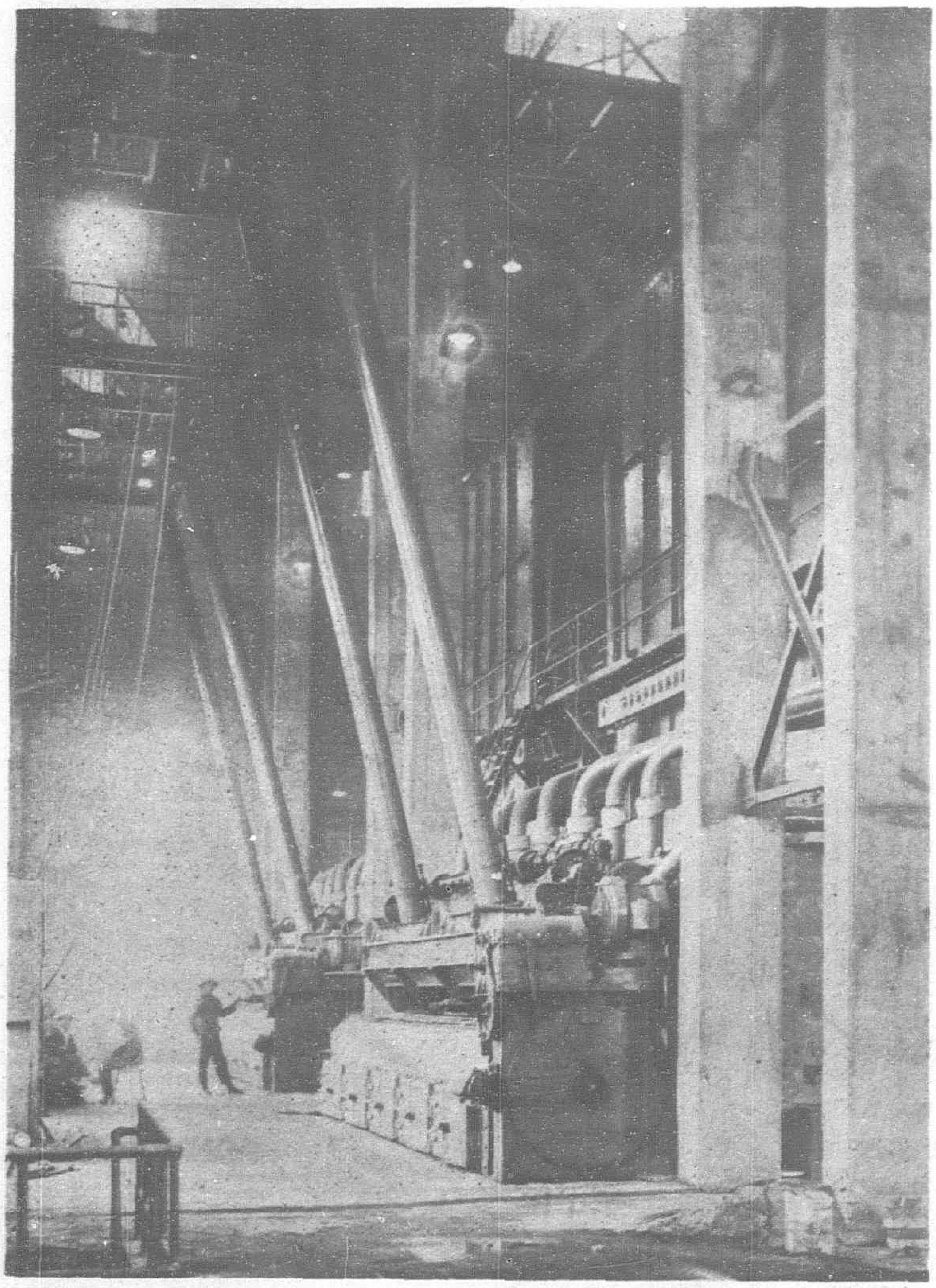
Type	*W.I.F.*	*W.I.F.*
Maker	*B. & W.*	*B. & W.*
No. of sets ..	8	6
Heating surface m²	374	770
Economizer H.S. m²	93	223
Fuel	gas	gas
Steam pressure Kgr/cm² ...	12.6	12.6
Steam temperature °C ...	330	270
Normal evaporation Kgr/hr...	5,500	12,200
Chimney	Brick 45.75 m. high	Steel 17 m. high

GENERATOR HOUSE

Type	*Horizontal type condensing steam turbine*	*Horizontal type bleeding steam turbine*
Maker	*General Electric Co.*	*A. E. G.*
No. of sets	3	2
Unit capacity kw.	3,000	1,500
Steam pressure Kgr/cm²	11.2	11.2
Steam temperature °C	298	298
Generator voltage	2,200	2,200
Phase	3	3
Cycle	60	60
Exciter kw.	25	16
Installed year	1916	1914

The Taikanton No. 1 Station

(1) No. 1 Station has a generating capacity of 30,000 kw. installed during the period 1921-1924. The coal used averages 5,000-5,500 calories per kgr., analyzing 20-25 per cent ash and 5-6 per cent moisture. The greater portion of small sized coal is sent to the pulverized coal plant and larger sizes to the chain grate stoker. Heavy clinkering troubles are not experienced.



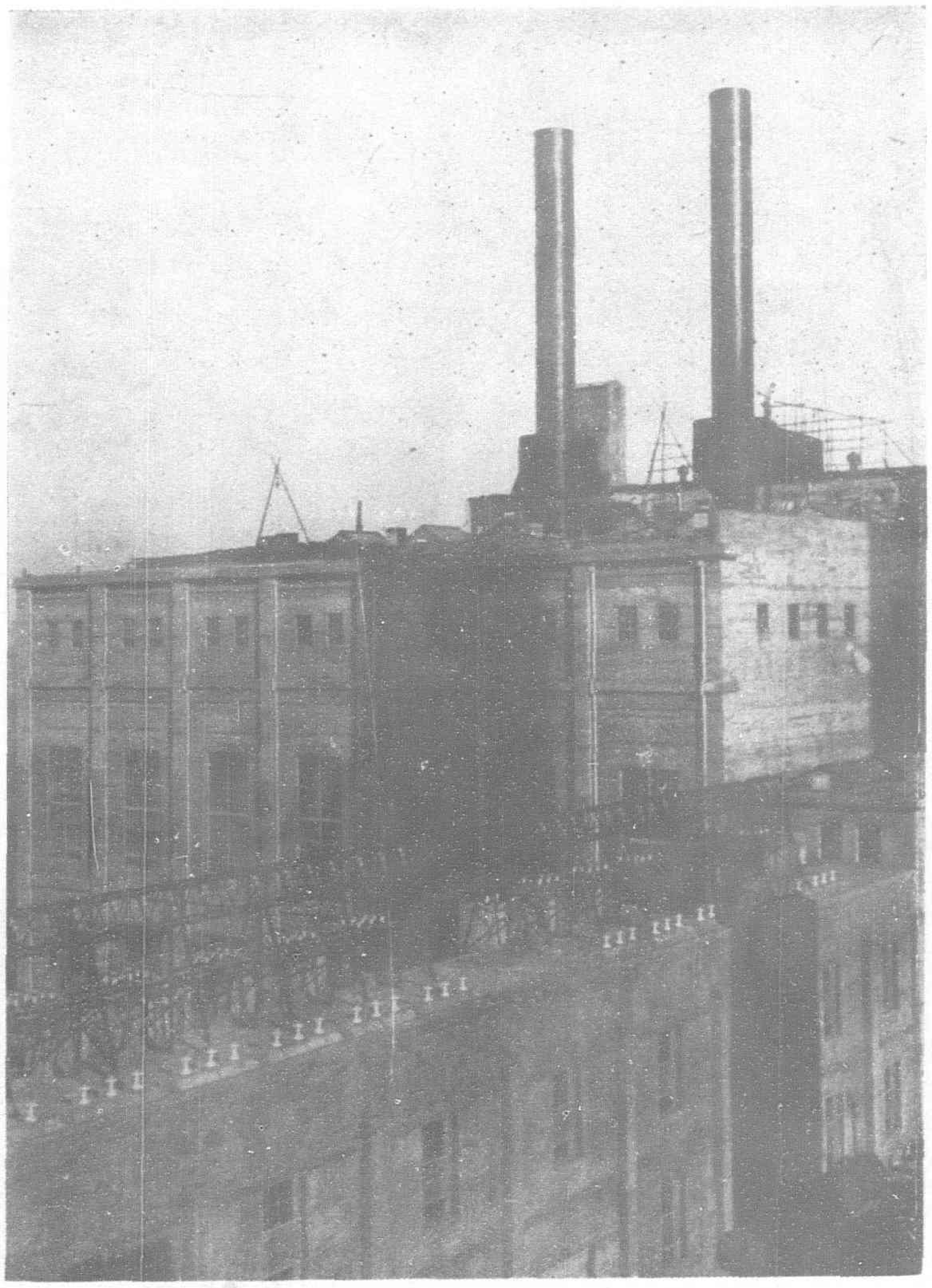
Boiler Room. Taikanton No. 2 Station

PULVERIZING PLANT EQUIPMENT :

Type	*Holbeck, central system.*
Capacity of coal bunker	450 tons
Type and capacity of dryer, rotary type	2, each 15 tons/1 hr.
Capacity of mill..	3, each 5 ,,
Capacity of pulverized coal bunker	2, each 50 tons
Distributing system	air distribution with blower, no return system.
Standard fineness 100.200 mesh.	80%, 65%.
Installed	1921

BOILER ROOM

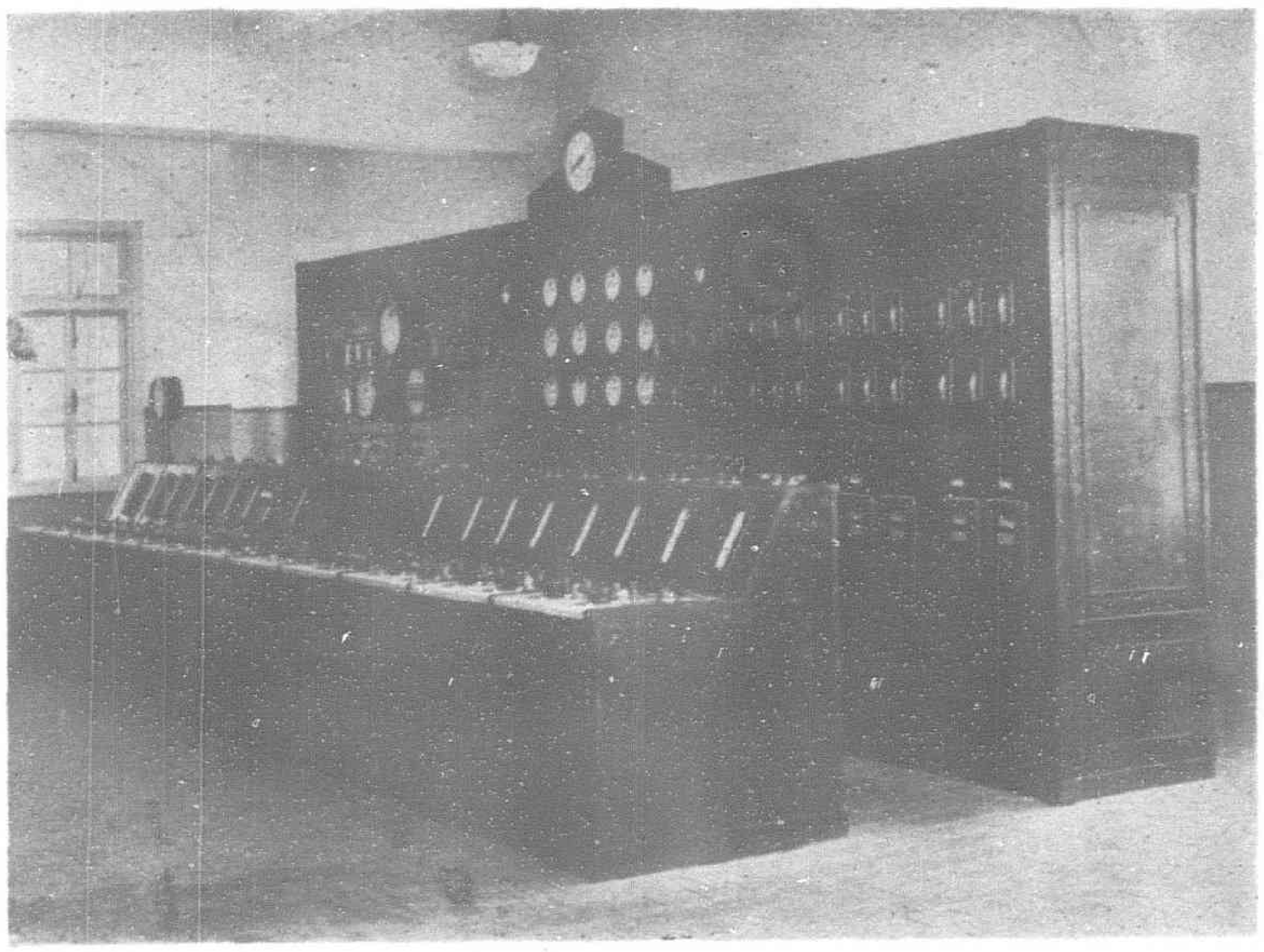
Type	*W.I.F.*	*W.I.F.*	*Garbe, 3 drum.*
Maker	*B. & W.*	*B. & W.*	*Mitsubishi*
Number	4	2	2
Heating surface m³	775	775	630
Superheater H.S. m²	230	230	170
Type of economizer	*Plain cast iron tube.*	*Plain cast iron tube.*	*Ribbed tube, cast iron.*
Economizer H.S.m³	380	380	1,040
Type of coal combustion and fuel.	*Chain grate.*	*Mond gas, powdered coal.*	*Mond gas, powdered coal.*
Steam pressure Kgr/cm³	17.5	17.5	17.5
Steam temperature °C	315	315	315
Normal evaporation Kgr/hr. ..	18,000	20,000	24,500
Maximum ,, ,, ..	23,000	25,000	29,500
Draft	natural	natural	natural
Chimney height m.	..80 (reniforced concrete)	90 (reniforced concrete)	



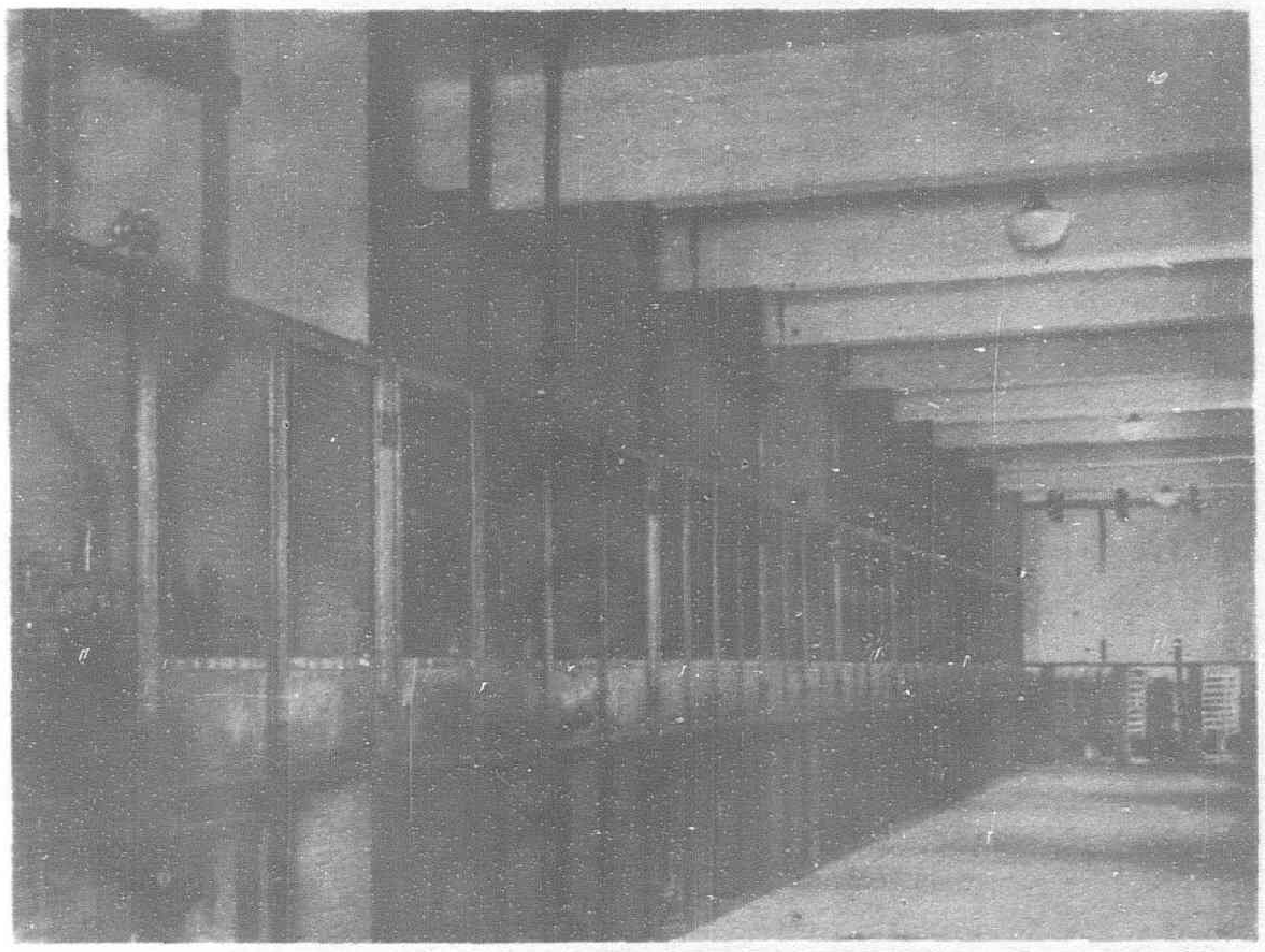
Electric Power Station, Fushun Collieries

The powdered coal burners are of high speed type, with an average combustion rate in the furnace of about 15,000 B.T.U. per cubic ft., and 18,000 B.T.U. maximum, without ash trouble. The powdered coal firing boiler has a bottom water screen, not front and side walls, with air cooling on side and front walls. Secondary air, therefore, is supplied through a wall air duct. Ash is removed from the bottom ash boxes sealing with water. Mixed firing of Mond gas and powdered coal gives very good results and better efficiency as compared with single firing.

The stokers are of a modern forced draft compartment type, able to burn at a rate of 20,000-25,000 B.T.U. per cubic ft. of furnace volume, without clinker trouble and higher loss in ash.



Controlling Board, Taikanton No. 2 Station



Interior of Taikanton Electric Power Station, Fushun Collieries (Switch Room)

GENERATOR HOUSE EQUIPMENT

	No. 1	*No. 2*	*No. 3*
Type	*Horizontal, single casing*	*Horizontal single casing*	*Horizontal double casing*
Maker	*G.E.*	*G.E.*	*Mitsubishi-S.S.W.*
Unit capacity kw.	5,000	12,500	12,500
Cos	.8	.8	.8
Steam pressure Kgr/cm^2	15.6	15.6	15.6
Steam temperature °C	245	300	300
Vacuum %	95	95	95
Condenser surface M^2	710	1,950	1,635
R.P.M.	3,600	1,800	3,600
No. of bleeding	—	—	single
Generator voltage	2,200	11,000	11,000
Phase	3	3	3
Cycle	60	60	60
Exciter kw.	100		50
Installed	1921	1921	1924

The 5,000 kw. turbo-generator has been provided with an automatic steam desuperheater to reduce the steam temperature and is always operated as a source of auxiliary power for No. 1 and No. 2 station. To the main bus, power is supplied through the step-up transformer directly connecting at the generator terminal.

EVAPORTING PLANT.—Using a bleeding steam from No. 3 turbine at a pressure and temperature 1.47 kgr./cm^2 gauge, 133°C respectively, double effect evaporators and a deaerator are installed to distil make up water and extract gas in feed water. Capacity of the evaporating plant is sufficient to treat all the feed water for the station boiler plant.

SWITCH BOARD GALLERY.—The switching gallery is installed on three floors; the top floor being divided into two sections, one for oil circuit breaker and the other for desk type controlling board and meter and relay board. The middle floor is also in two sections, one for bus-bar of duplicate system, and the other for choking coils and disconnecting switches. The bottom floor is used for the step-up transformer of the 5,000 kw. generator and for auxiliary power oil circuit breakers. Eight feeders, three tie lines between power stations and the generator mains are connected to the bus-bar. Generators are protected by differential and over load relays with G.E. induction type overload relays for all feeders. Bus-bar and conductors are segregated by a partition wall and the source of a remote control of all mechanism is direct current from batteries. Each feeder is rated 5,000 kw. power supply with rupturing capacity of 350,000 kva. or 600,000 kva.

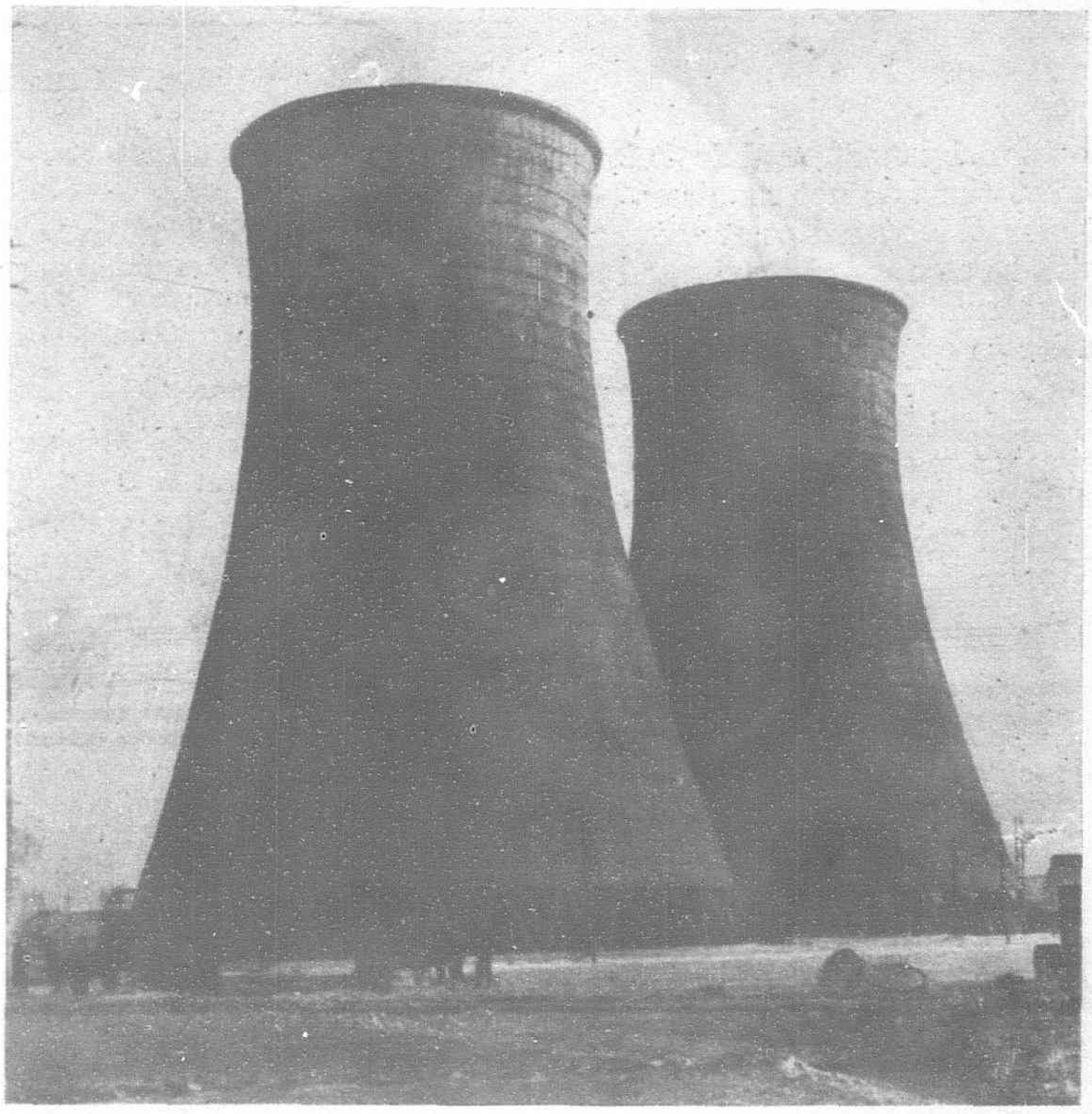
RECOOLING EQUIPMENT OF CONDENSER COOLING WATER.—A spray cooling pond is provided for recooling circulating water and is able to deal with water for 25,000 kw. running in winter season.

No. 2 Taikanton Station

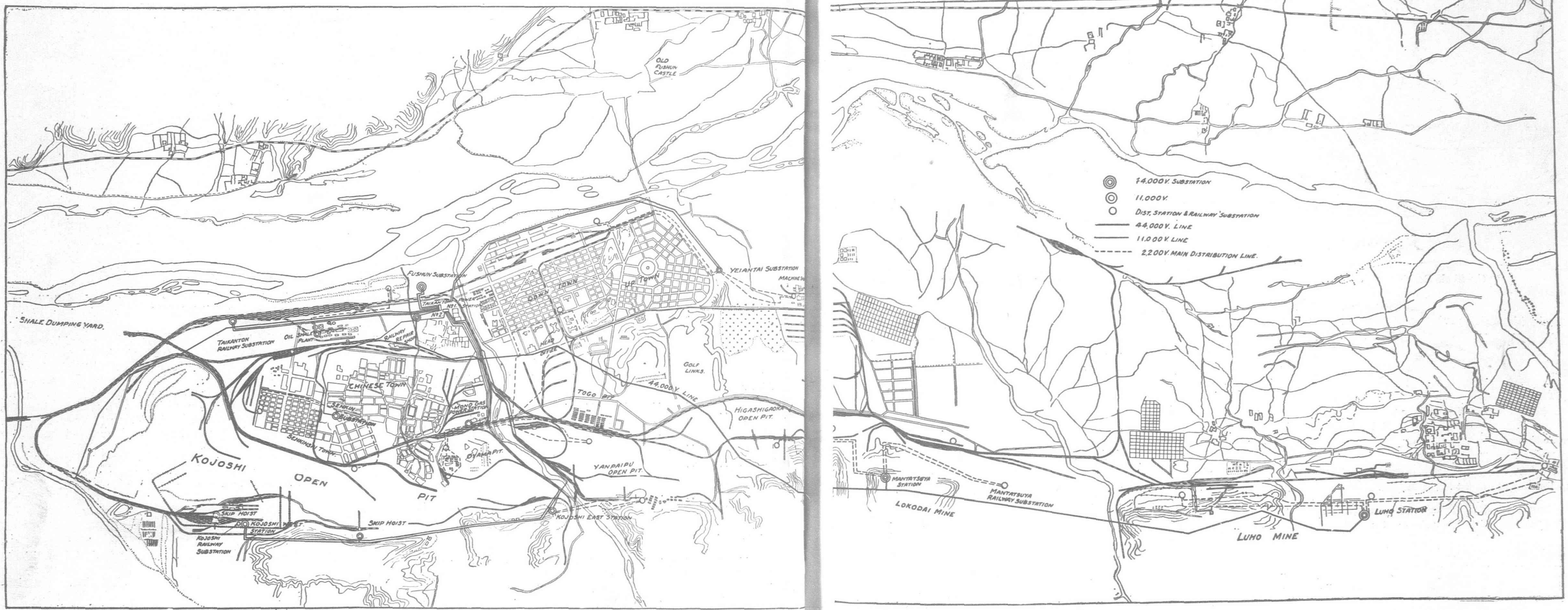
To take care of the rapidly increasing requirements of the Fushun power system, it became necessary to instal additional generating capacity. A new site was therefore selected 20 meters distant from and adjoining the Taikanton No. 1 station. In designing the plant, simplicity, ease of operation, lowest initial cost compatible with high economy, high pressure, high temperature and intensive use of equipment available, were the primary factors considered.

Including the size of the units and the early station load, a throttle pressure 25 kgr. $1\ \text{cm}^2$ gauge and 385°C was estimated to give the highest commercial economy, because the cost of coal at the station is very cheap. Stokers were chosen, as their adoption tended to eliminate certain complications. The economizers have 46 per cent as much surface as the boilers and air heaters with 170 per cent of the boiler surface reduced flue gas temperature 122°C when operating normal rating. The main turbines are at two tapping points to heat the feed water and evaporate make up water to eliminate scale trouble.

Combustion air is preheated up to 140 degrees C. and sent to the furnace through the fuel bed or introduced in small amounts



Taikanton Electric Power Station, Fushun Collieries (Cooling Tower)



General Plan of Fushun Collieries, Showing Pow Houses and Transmission System

over the fire at the front of the ignition arch by two forced draft fans of the individual boiler. The Fushun stations do not require a big coal storage plant as a large amount of coal is stored at every open mine and pit mouth. This station will be completed by the end of June, 1931, but one of the 25,000 kw. generators began running at the end of November, 1930. The ultimate capacity of the plant is expected to reach 100,000 kw.

COAL TRANSPORTATION.—Coal is received by 50 or 60 tons cars and tipped on track hopper. Shaking conveyors, belt conveyors, coal crusher, automatic operating skip hoists and steel belt conveyor are used between the coal hopper in the boiler room and the track hopper. This transportation system has a handling capacity of about 80 tons of coal per hour, measured and weighed on the belt conveyor.

ASH HANDLING EQUIPMENT.—By a combination of apron and gravity bucket conveyors, the ash is transported to a 100 tons capacity ash hopper standing at the track and loaded on the electric train made up of 40 ton air dump cars to be carried away to the dump.

BOILER HOUSE

Two boilers, sufficient to generate steam for 25,000 kw. with one kept as spare are installed.

Maker	*Toyo B. & W. Co.*
Type	*C.T.M. Cross drum.*
Boiler heating surface m²	1,470
Super heater heating surface m²	410
Economizer heating surface m²	675
Air heater heating surface m²	2,500
Heating surface of furnace cooling m²	50

Maker	*Toyo B. & W. Co.*
Type	*C.T.M. Cross drum.*
Grate area (single stoker 7.62m by 7.3m) m²	55.76
Combustion gas temperature at normal rating deg. C.	
in combustion chamber	1,425
Boiler exit	330
Air heater exit	122
Feed water temperature °C	
Economizer inlet	130
Economizer outlet	178
Preheated air temperature C	
Air heater inlet	25
Air heater outlet	140
Steam pressure Kgr/cm²	
at drum	29
at superheater exit	27.5
Steam temperature C	400
Efficiency	84%
Normal evaporation Kgr/hr.	60,000
Max. evaporation	66,000

Two forced draft fans, one induced draft fan with a speed controlling device and one dust catcher are provided for each boiler. High and low water level signal, Cope's regulator, large dial steam pressure gauge load indicator,—Bailey boiler meter, draft gauge, Co ²-recorder and other necessary instruments are also pvovided.

GENERATOR HOUSE

Maker	*Mitsubishi*
Unit capacity k.v.a.	31,560 k.v.a.
Number	2

Type	*Single cylinder, high efficiency.*
Steam pressure, Kgr/cm²	25
Steam temperature C	385
Vacuum %	96.7
Condenser surface m²	2,350
Circulating water quantity m³/hr.	6,750
No. of bleeding	2
R.P.M.	1,800
Generator Voltage V	11,000
Phase	3
Cycle	60
Exciter kw.	120

Steam consumption and generator efficiency at most economical load are guaranteed 3.96 Kgr. kw.h. at straight condensation and 96.6 per cent respectively. Two circulating pumps (60 per cent of normal capacity) are provided for each unit.

HEATING EVAPORATING AND DEAERATING PLANT.—Two evaporators; one high pressure, one low pressure heater and evaporator condenser are provided for each turbine and deaerating action is done by special design of the main condenser.

Output kw.	*Make up water Kgr/hr.*	*Final feed temp. °C*
25,000	2,750	135.5
20,000	2,130	129.5
15,000	1,630	121.4

RE-COOLING WATER TOWERS.—Two all-concrete cooling towers are sufficient to cool down the circulating water for 25,000 kw. generation in summer and one in the winter season. Compared to the spray cooling pond, it is more efficient, requiring smaller space and less make up water, but the installation cost is about 15 per cent higher.

SWITCHING GALLERY.—The switch board equipment is sectioned in three rooms, one for the controlling boards, one for the bus-bars and others for the oil circuit breakers and twelve feeders going out to the substations. On the tie line between No. 1 and No. 2 stations, to protect the oil circuit breaker explosion in No. 1 station, is inserted an 8 per cent reactance coil. The rupturing capacity of oil circuit breakers in No. 2 station is 850,000 k.v.a. The most up-to-date protection system for the generators and the feeders are used and recording instruments are provided for the principal parts. Power cable canal and lead cable canal are provided for easy inspection and installation.

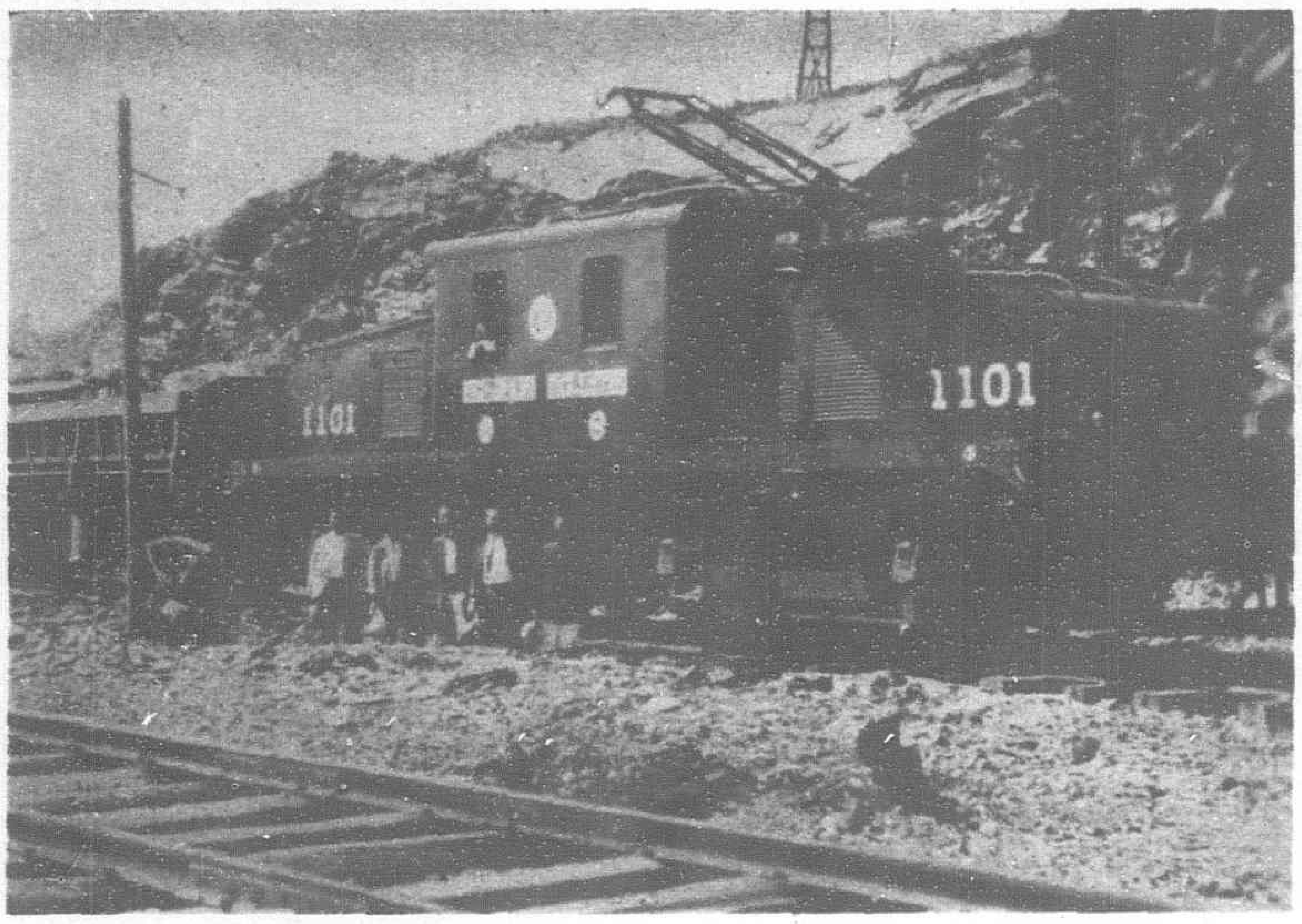
TRANSFORMER SUBSTATIONS

Four step-down and one step-up transformer stations are operating; two step-down and one step-up transformer stations under construction will be completed in July, 1931, as shown in the map.

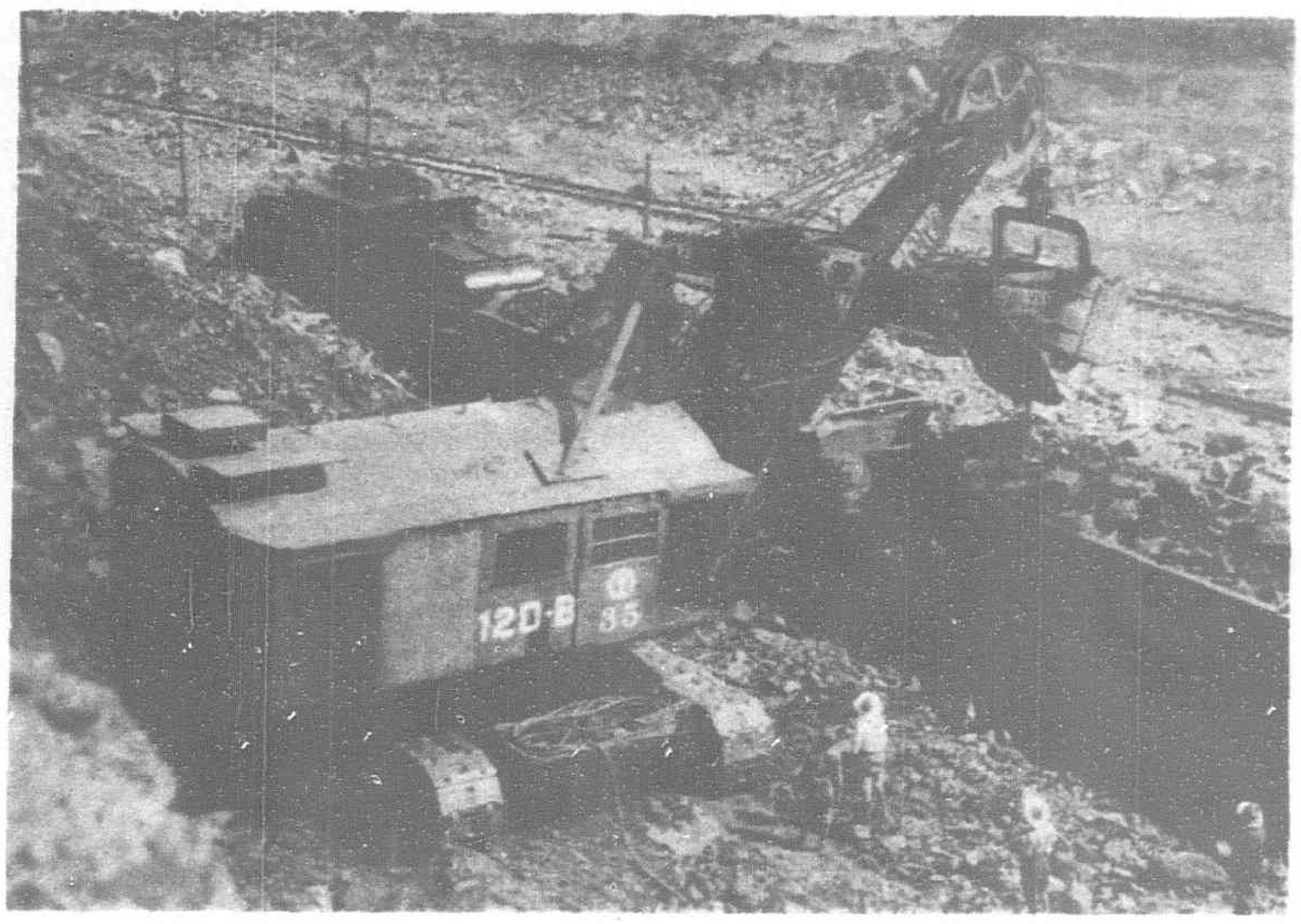
The standard voltage in Fushun is 44,000 and 11,000 v. for transmission lines, 6,600 v. for large capacity motors, 2,200 v. for distribution main or medium size motors and 220, 100 v. for small power or electric lighting respectively.

FUSHUN STEP UP TRANSFORMER STATION

Power is transmitted to Mukden-Liaoyang-Yentai-Tieling-Kaiyuan through this station. Total length of the transmission lines is about 250 km.



85 tons Locomotive collects current by the Slide arm collector at the Shale Bench



85 tons Electric Locomotive at the Shale Bench, in Kojohi Open Pit. Loading Shale on Dump Cars by 120 Bucyrus Electric Shovel

Location	*Taikanton,*	*Fushun*
Transformer capacity (single phase)	2,000 kva.	1,000 kva.
Number	4	4
Max. transmitted kva.		10,000 kva.
Primary voltage		10,000 v.
Secondary voltage		44,000 v.
Earth protection	Petersen coil at neutral	

TAIKANTON STEP-UP TRANSFORMER STATION

(Out door substation, under construction)

Location	*Taikanton power station*
Transformer capacity (three phase)	12,000 kva.
Number	2
Primary voltage	10,000 v.
Earth protection	Petersen coil at neutral

Power supplies to eastern district in Fushun.

LUHO STEP-DOWN TRANSFORMER STATION

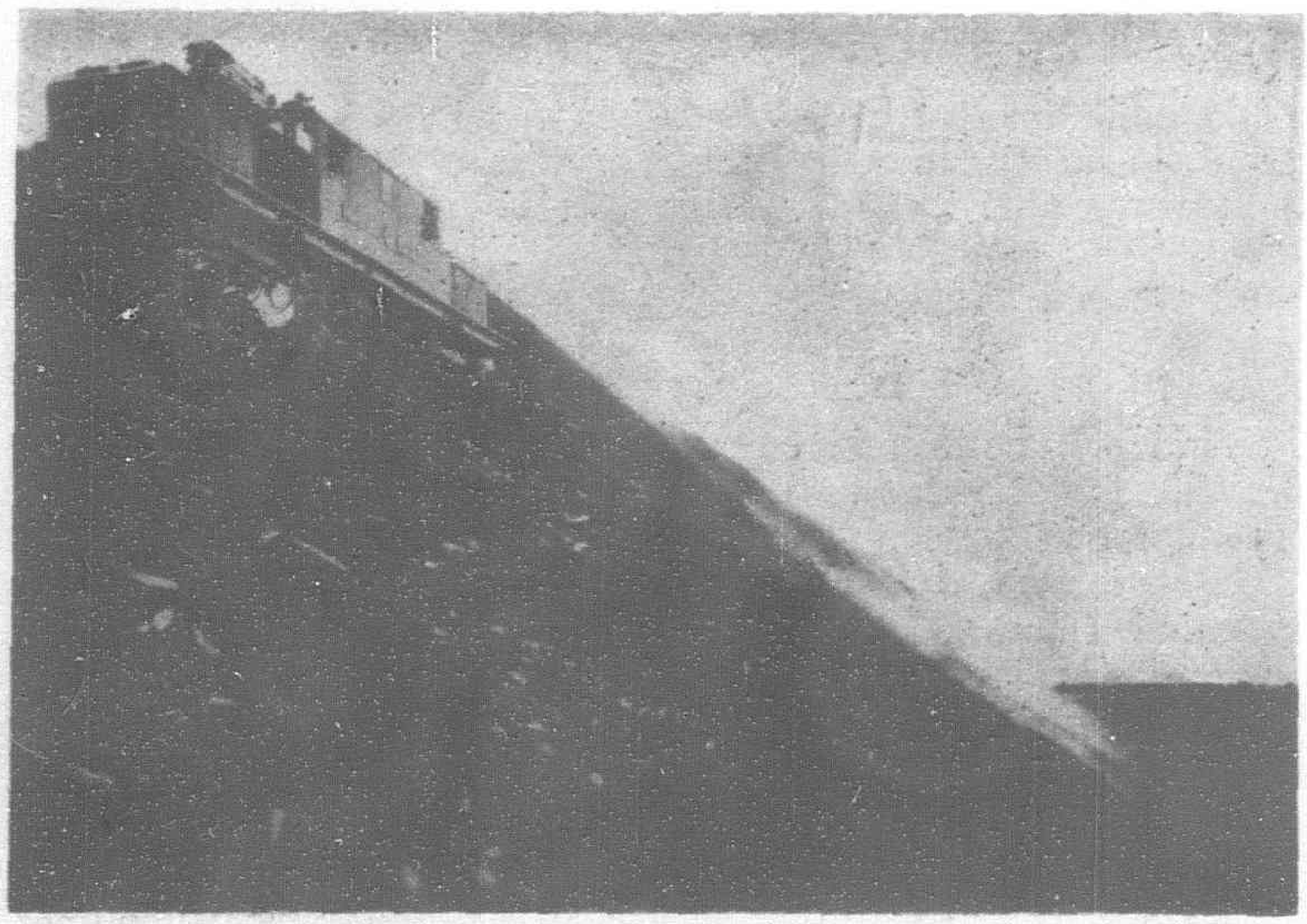
(Out door substation, under construction)

Location	*Luho mine*
Transformer capacity (three phase)	6,000 kva.
Number	2
Primary voltage	40,000 v.
Secondary voltage	2,200 v, 6,600 v.
Secondary feeders	about 6

MANTATSUYA STEP-DOWN TRANSFORMER STATION

(Out door substation, under construction)

Location	*Mantatsuya mine*
Transformer capacity (three phase)	6,000 kva.
Number	2
Primary voltage	40,000 v.
Secondary voltage	2,200 v, 6,600 v.
Secondary feeders	about 6



Dumping Shale at the Dumping Yard

KOJOSHI WEST STEP-DOWN TRANSFORMER SUBSTATION

(Indoor substation)

Location	*Kojoshi open mine*
Transformer capacity (single phase)	1,250 kva.
Number	4
Max. transmitted kva.	3,750 kva.
Primary voltage	10,000 v.
Secondary voltage	2,200 v.
Neutral earthing	No.
Secondary feeders	9

KOJOSHI EAST STEP-DOWN TRANSFORMER SUBSTATION

(Indoor substation)

Location	*Kojoshi open mine*
Transformer capacity (single phase)	1,250 kva.
Number	4
Max. transmitted kva.	3,750 kva.
Primary voltage	10,000 v.
Secondary voltage	2,200 v.
Neutral earthing	No.
Secondary feeders	6

SENKIN STEP-DOWN TRANSFORMER SUBSTATION

(Indoor substation)

Location	*Senkinsai, Fushun*
Transformer capacity (single phase)	1,250 kva.
Number	4
Max. transmitted kva.	3,750 kva.
Primary voltage	10,000 v.
Secondary voltage	2,200 v.
Neutral earthing	No.
Secondary feeders	8

YENTAI STEP-DOWN TRANSFORMER SUBSTATION

(Indoor substation)

Location	*Yentai, city water reservior, Fushun*
Transformer capacity (three phase)	1,500 kva.
Number	3
Primary voltage	10,000 v.
Secondary voltage	2,200 v.
Neutral earthing	No.
Secondary feeders	8

Power feeds to the waterworks and the machine shop

The 44,000 v., 11,000 v. transmission lines are to be protected by most up-to-date relay combination for overload, phase, short circuit or earthing phenomena and 2,200 v. circuits are also protected by ordinary induction type overload and reverse power relays.

TRANSMISSION AND DISTRIBUTION LINES

The principal transmission and distribution lines between the power houses and the substations are constructed as a duplicate line system for power supply reliability.

Surface lines are strung on wooden poles or steel towers and power cables are used for underground mines.

Length of Lines (1930)

Extra high tension lines	49 km. (not included Mukden line)
High tension lines	212 ,,
Low tension line	328 ,,
Installation h.p. of electric motors (1930) 66.826 h.p.	(only Fushun, except D.C. motor, not included other city)

Electric Railway

The steam locomotives were replaced by electric locomotives in October, 1914, for the surface lines to transport coal, sand and other material as well as for passenger service. Regarding this electrification, it may be interesting to note that it is the pioneer to use high voltage, 1,200 v. D.C. in the Far East. Since then a continuous expansion of electrification has been carried on for transportation at the open pit and underground mines.

Surface Line

Coal from all pits is transported to the terminal of the S.M.R. main line. The transportation of materials for the use of stowage mining from their collecting stations to pits, as well as all other interpit freight and passenger service, are under the care of the Transportation Department. The length of track is 160 km. and existing rolling stock is as follows :—

Locomotives.

Self weight in English (ton)	*Maker*	*Number*	*Motor h.p.*	*Tractive effort at rated current kgr.*	*Speed at rate current km/hr.*
73	Shibauro	2	4 by 290	9,800	31
,,	Kawasaki ..	3	4 by 275	14,800	23.4
50	S. M. R.	3	4 by 125	6,560	20.8
,,	General Electric ..	13	4 by 125	7,200	16.2
,,	A. E. G.	4	4 by 110	7,400	17
25	S. M. R.	5	2 by 55	1,368	24
,,	A. E. G.	4	2 by 55	1,368	24

Passenger cars	*Number*	*Motor h.p.*	*Seat capacity*	*Speed at rated current*
Motor car	9	2 by 80	80	24.7
Trailer	17	—	80	—
Motor car	2	4 by 40	—	24.2

Freight cars

Number	*Construction*	*Loading capacity tons*
375	Wooden	30

The electric source of current is direct current 1,200 v. and the line construction is of single wire, five points catenary suspension, the span between poles being 45 meters at tangential track. Wooden poles are mostly used. To facilitate safety and prompt service, a color-light automatic block signal system is ued for the whole line, sectioned into about 105 parts. In 1928, 13,000,000 tons of freight and 7,000,000 passengers moved on this track.

Open Pit Line

There are three open pit workings in Fushun. The largest, called the Kojoshi Open Pit, is situated along the western terminus of the Fushun coal seam where its maximum thickness expands to 140 meters with 88 meters as an average. The coal seam is covered by brown and green shale, the former being oil bearing, which is sent to the Oil Shale Plant, for treatment. For a long time, the economic limit of depth for open mining, was believed to be 225 meters, but with the increasing efficiency of working and improved mechanization, it is year by year becoming deeper. The principal difficulties in open pit mining is the shale excavation and its transportation. Electric shovels are used for this purpose at every bench of 10 meters high. The yearly excavation of shale and alluvium is more than 6,000,000 solid cubic meters which is transported to the oil shale plant or the dumping yard about 10 km. distant. These railways on the inclines connecting with the main line, have a 1.5 per cent grade with 1 per cent on the benches. For the electrification of these heavy grade lines in the Kojoshi and Yanpaipu Open Pits, the first scheme was completed in August, 1929. More than thirty electric locomotives are in use for this service.

Each locomotive has one pantograph for the permanent way and two side-arm collectors for the shale benches or dumping yard to collect current from 1,200 v trolley wire of single catenary suspension or direct suspension constructions.

Locomotives		
Weight in tons	85	55
Working place	Kojoshi Open Pit	Yanpaipu Open Pit
Trolley voltage v.	1,200	1,200
Main motor h.p.	4 by 325	4 by 150
Speed at rated current km/hr. ..	24	18
Tractive effort kgr.	14,800	9,100
Hauling load at level tons	5,172	4,864
Track gauge m.m.	1,435	1,435
Makers and numbers		
Shibaura S.	5	—
Hitachi S.	6	—
Mitsubishi D.S.	1	3
Siemens S.W.	4	—
Total	16	3

All locomotives were specially constructed to meet heavy duty, on difficuit road beds ; 85 ton locomotives hauling nine 40 cubic yards steel air dump cars composing each train, the 55 ton locomotives haul eight 25 cubic yards steel air dump cars in one train.

Coal Transportation at Coal Bench in Open Pit

Thirteen 12 ton locomotives operate in the Kojoshi Open Pit to transport coal and dirt excavated by small electric shovels to the bottom of the big electric skip hoists. The current is D.C. 500 v. collected through side-arms, but for emergency, a cable reel with 100 meters cable is mounted on the end cab. The locomotive hauling about 20 tubs of four ton capacity compose one train, run on round trips between the hoist bottom and attacking face.

Locomotives	
Number	13
Main motor h.p.	2 by 45
Speed at rated current km/hr.	12
Tractive effort kgr.	2,080
Hauling load in tons..	180
Track gauge m.m.	900
Maker	*Mitsubishi D.S.*

Coal Transportation at Surface

Four 12 ton and one 5 ton locomotives are used for coal transportation between the Togo and the Tanpaipu Bits :

Locomotives		
Number	4	1
Self weight in tons	12	5
Main motor h.p.	2 by 45	2 by 20
Speed at rated current km/hr. ..	12	10.4
Tractive effort kgr.	2,080	970
Hauling load kgr. tons	180	30
Track gauge m.m.	900	609
Maker	*Mitsubishi D.S.*	*General Electric Co.*
Working voltage v.	500	500

Coal Transportation Underground

On the main underground mine railways small locomotives hauling small coal tubs are used :

Name of Pit	*Togo*	*Lokodai*	*Oyama*
Working voltage v. (D.C.) ..	250	500	250
Self weight in tons	5	5	5
Number	3	2	4
Main motor h.p.	2 by 20	2 by 20	
Tractive effort kgr.	952	907	
Track gauge m.m.	609	609	609
Maker	*Siemens S.W.*	*General Electric Co.*	*Toyo D.S.*

Railway Substations

There are three 1,200 v-substations, three 500 v-substations and two 250 v-substations in Fushun supplying D.C. power for the railway electrification.

1,200 v. Substations

Name of substation	*Taikanton*	*Mondgas*	*Mantatsuya*
Kind of generator	*Mercury rectifier*	*M-G.*	*M-G.*
Unit capacity kw.	1,100	750	400
Number	4	3	3
Total available output in kw. ..	4,400	2,250	1,200
No. of feeders	3	3	2
Maker	*B.B.C. & Hitachi S.*	*Siemens. S.W. & General Elec.*	*General Elec. Co.*

The D.C. generator main and feeders are protected by high speed circuit breakers and other necessary and up-to-date instruments and relays. Transformer connection for the mercury rectifier is double-six phase with cathod reactance and supplies current to 12-anode rectifier. Since 1926, we have not experienced any severe troubles with the rectifier and operate at a very much higher efficiency compared with M-G. sets.

500 v. SUBSTATIONS

Name of substation *Kind of generator*	*Kojoshi* *Syn. Converter*	*Yanpaipu* *Syn. Converter*	*Lokodai* *M-G.*
Unit capacity kw.	400	200	50
Number	2	1	2
Total available output kw. ..	800	200	100
No. of feeders	3	1	2
Maker	*Fusi D.S.K.*	*Mitsubishi D.S.*	*Oerlikon*

250 v. SUBSTATIONS

Name of substation *Kind of machine*	*Togo* *M-G.*	*Oyama* *M-G.*
Unit capacity kw.	100	100
Number	2	1
Total available output kw. ..	200	100
No. of feeders	2	2
Maker	*Shibaura S.*	*Yasukawa D.S.*

For underground electrification, we chose 250 v. D.C. as the best voltage for a small locomotive and 500 v. D.C. for a larger size locomotive.

PRINCIPAL INSTALLATION OF ELECTRIC MACHINES IN FUSHUN MINES

The future of machine mining in Fushun presents a very interesting problem, in order to increase the amount of coal produced per head of labor up to a steady average of 7 or 8 tons per day. The output is sometimes over 20 tons, at present. In the open pit working, we have already furnished complete mechanization and reduced human labor to a minimum. The principal installation of electric machinery is as follows :—

(1) Hauling Gears

Capacity of motor h.p.	*Type of Haulage*	*Voltage v.*	*Number of sets*	*Daily output of coal in ton*
300 (one hour rating)	.. ..	2,000	26	—
150 ,,	Single rope, Single drum, A.C., shipring type induction motor with speed controlling device of metallic resistance	,,	24	
75 ,,	.. ..	,,	21	
50 ,,	.. ..	,,	8	
1,100 continuous rating	Water reheostat speed controlling system, single drum, single rope	6,000	2	5,000
*1,300 continuous rating	Double drums, double ropes, speed controlling device same as above	6,000	3	7,500

*Now under construction.

Makers are mostly Japanese, but the 1,100 and 1,300 h.p. haulage gears are supplied by the S.S.W. and A.E.G. in Germany.

(2) Pumping sets

Motor h.p.	*Number of sets*	*Manometric head in ft.*	*Quantity of water in cub. ft.*
1,320	3	1,480	270
1,200	2	1,300	200
900	2	1,320	240
550	4	1,000	200
500	2	1,320	120
470	2	1,320	120
460	7	1,200	130
460	5	800	200
450	2	800	200

Makers are mostly Japanese.

(3) Electric shovels are supplied by the Bucyrus-Erie and the Marion Company. One of 50-B type made by the Kobe Steel Works in Japan, is giving good results. The 50-B type are used for coal mining and the bigger machines for shale excavation.

Type of shovel	*Number of sets*	*Dipper capacity cub. yard*	*Actual working rate cub. yard of shale per day by solid measure*
200-B.	2	6	2,500
120-B.	8	4	2,500
103-C.	1	4	1,500
—	1	2.5	1,000
50-B.	2	2	800

Type of shovel	*Number of sets*	*Dipper capacity cub. yd.*	*Actual working rate ton of per day*
50-B.	11	2	1,000
50-B. extra high lift	2	1.5	700

One of 200-B is now under construction. Mark " B " means a revolving type and Mark " C " a swing type.

The Hankow Light and Power Co., Ltd.

(*Continued from page 300*).

eight, the additional five all being of 3,140 sq. ft. heating surface and 10,500 lb. per hour evaporating capacity. The five large boilers have all recently been equipped with superheaters. The steam pressure is 165 lb./sq. in. and the temperature at the engine stop valve is 540/570 deg. F. The improvements carried out during the past four years in the boiler house and generating station including the installation of superheaters, feed water preheaters, additional circulating water facilities, etc. have brought about a reduction in coal consumption of approximately 65 per cent and the present boiler house efficiency is 83 per cent.

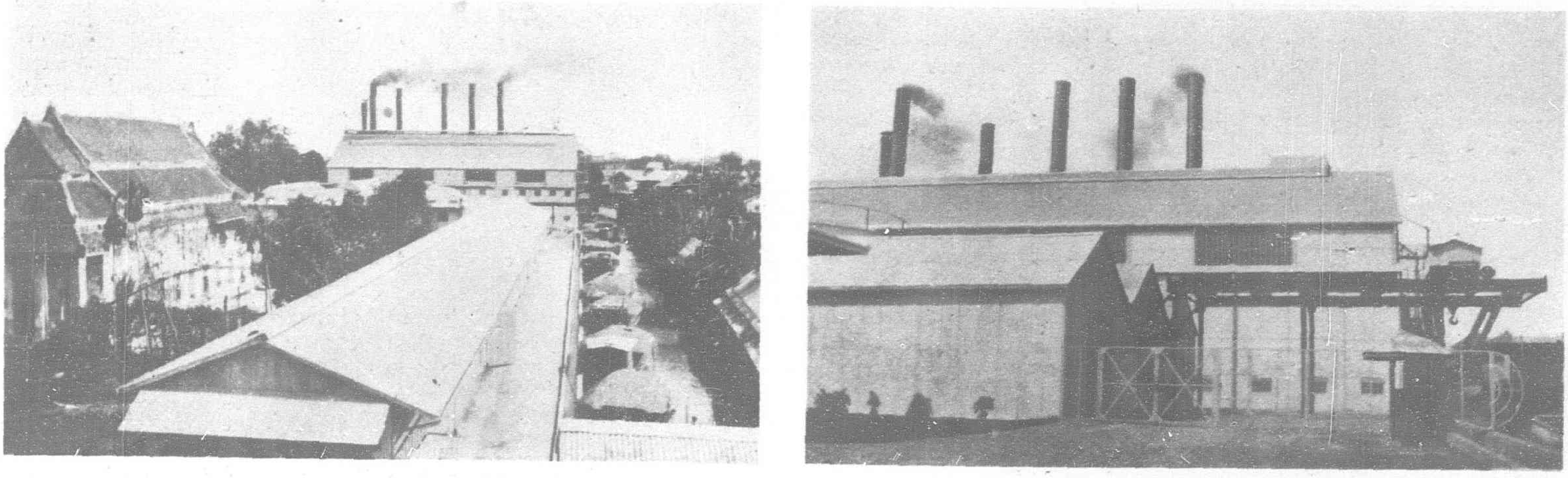
5. DISTRIBUTION NET WORK.—The distribution of current is effected entirely by means of overhead mains and services which are carried on steel lattice work poles, the cabling being almost entirely triple braided and stranded hard drawn copper wire of British manufacture. A large number of improvements and alterations had been carried out in the net work during the past four years involving the expenditure of quite a large amount of money but the reduction in distribution losses has been considerable. The most important improvement effected was the installation of a heavy calibre ring main encircling the French Concession and linking up the existing feeders.

6. REPAIRS, ETC.—It is worthy of note that all maintenance and repair work in the Generating Station is carried out by our own Chinese fitters, and we venture to assert that their work compares most favorably in quality with that of English or American trained mechanics who have served their time in the use of tools in the ordinary way.

On the electrical side the Company also carries out all repairs to its own electrical machinery of all descriptions and does considerable of this sort of work for outside clients. They also test and repair all their own meters.

7. SALES DEPARTMENT.—A separate sales organization was created about four years ago and new showrooms were built which have since been enlarged as the business expanded. This department acts as agents for the whole of Central China for about 24 firms of manufacturers nearly all of whom are British, and they are doing a fair amount of business and show signs of expanding in the future when the currency becomes more stabilized. They also carry out a large amount of work in installations, wiring contracts, etc.

8. GENERAL REMARKS.—Due to the very rapidly increasing load on the station during the last winter season it is proposed to augment the existing generating plant by the purchase of a 2,500 kw. continuous maximum rating self-contained turbo generator set driving a shunt wound generator through speed reduction gears, and at the present time tenders are being considered from two British firms of manufacturers of this type of turbine. It is not proposed, however, to increase the steam pressure by the purchase of new boilers, but merely to raise the temperature by the installation of an independently fired superheater.



Siam Electric Corporation Power Station at Bangkok

Power Station Premises seen from the 1st Floor of Office Building

Power Station

Bangkok's Electrical Supply

ONE of the great power developments in the Far East is found in Bangkok, the capital of Siam, where the Siam Electricity Company, Ltd., holds a virtual monopoly for furnishing light and power to the city and its suburbs. The history of this development goes back to May, 1887, when a concession was granted by the Siamese government to Messrs. John Loftus and A. du Plesis de Richelieu to operate a horse-drawn tramway from Bangkolem (the southern-most point of the town) to the royal palace. The concession was transferred to an English company (the Bangkok Tramways Company, Ltd.) which worked it for some years with but poor results. This company went into liquidation, and on May 23, 1892, transferred the concession to a Danish company.

This company electrified the line (which work was completed in May, 1894, at a time when most cities in Europe were without electric tramways) and operated it for some years until in November, 1900, the concern was taken over by the Electricity Co., Ltd.

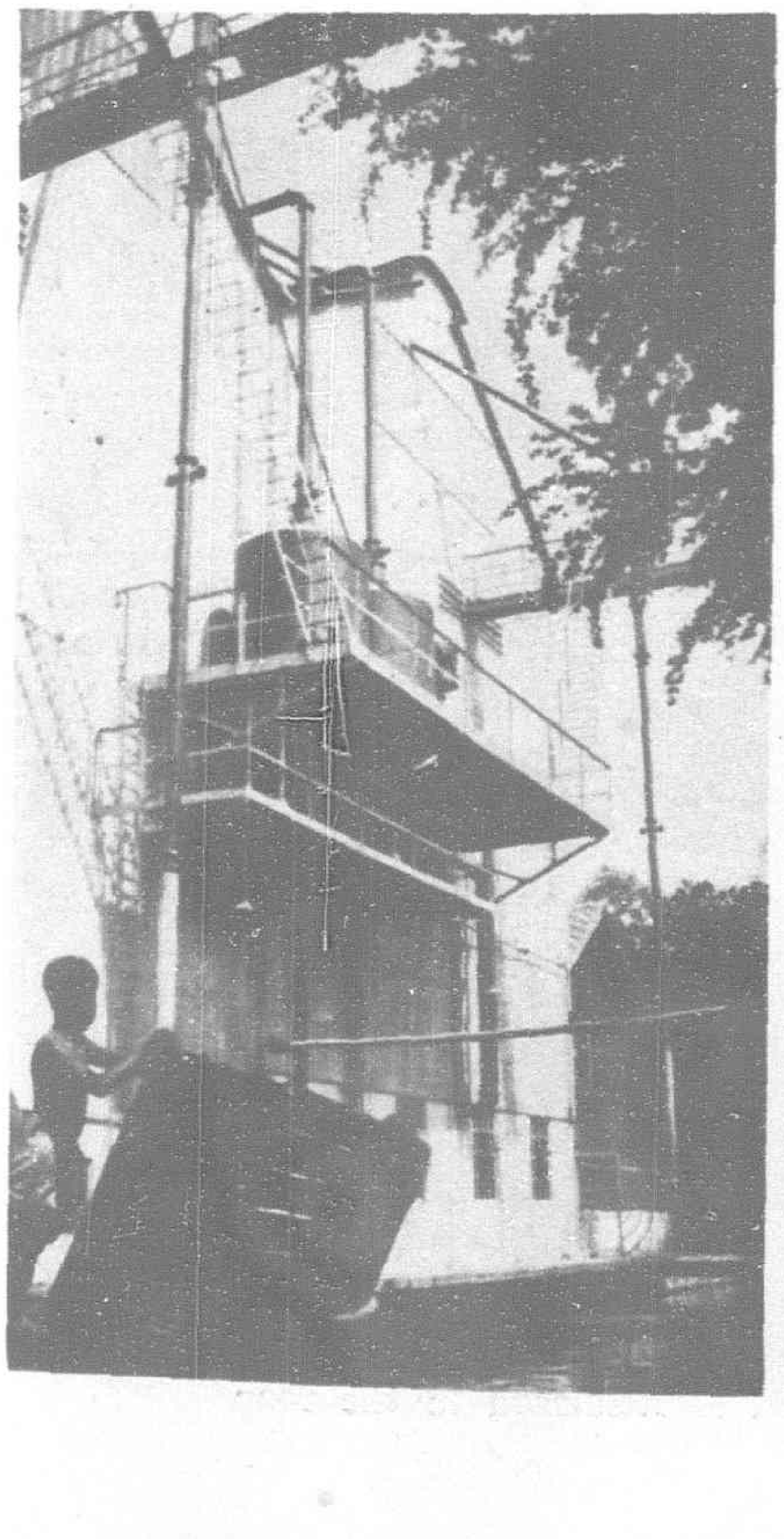
Independently of these developments Messrs. L. de Richelieu and Aage Westenholz obtained in July, 1900, another concession to construct and operate a tramway (the Samsen Tramway) which connected the northern part of Bangkok with the center of the town and this concession was also transferred to the Siam Electricity Co., Ltd., and traffic was commenced on this line in September, 1901.

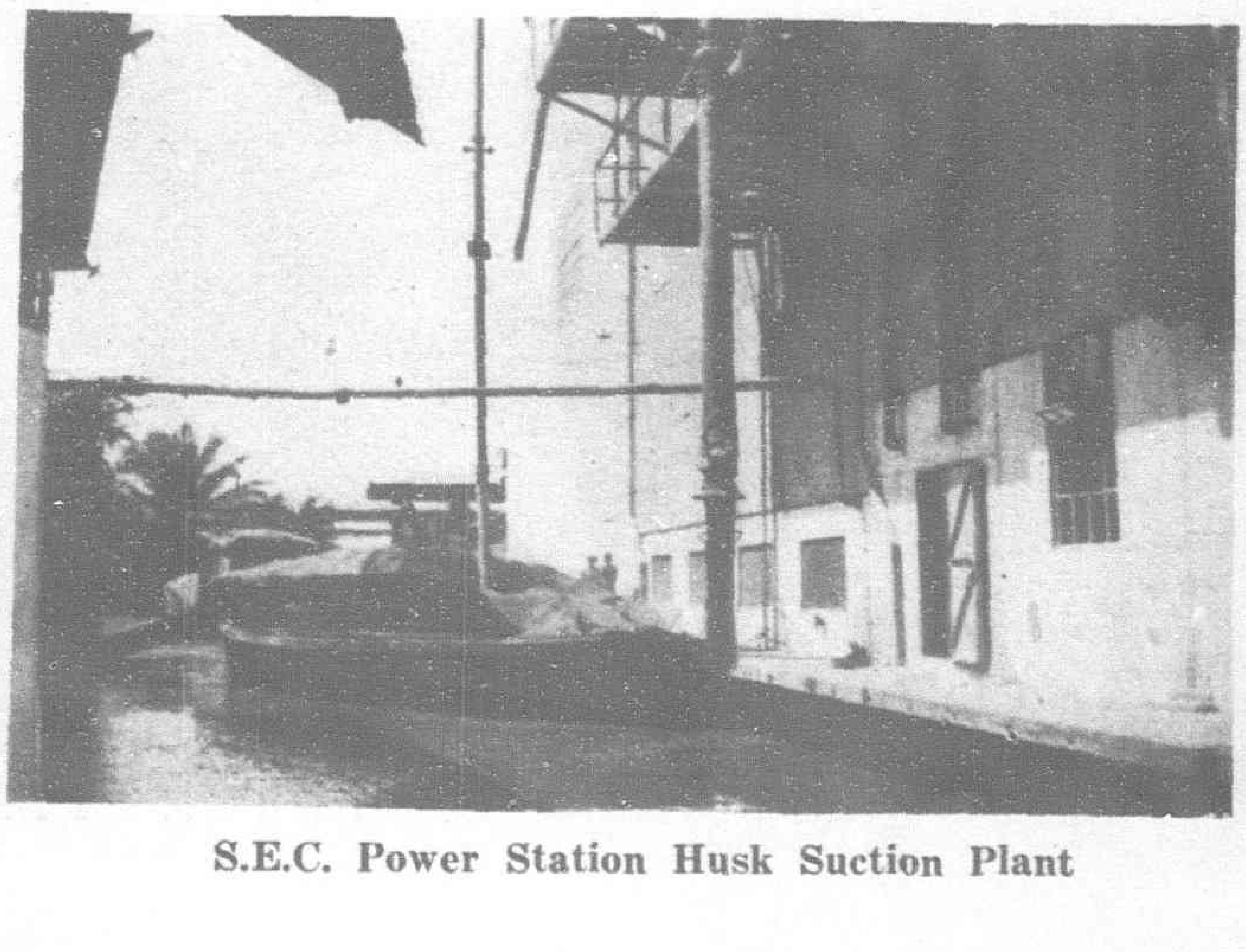
Electric lighting was first started in Bangkok by a Siamese nobleman in 1890 and was taken over by the government in 1893. It was transferred to an American company, the Bangkok Electric Light Syndicate, in 1897 and this company obtained a contract for lighting of public roads and government premises which contract after certain alterations was taken over by The Siam Electricity Co., Ltd., upon its formation.

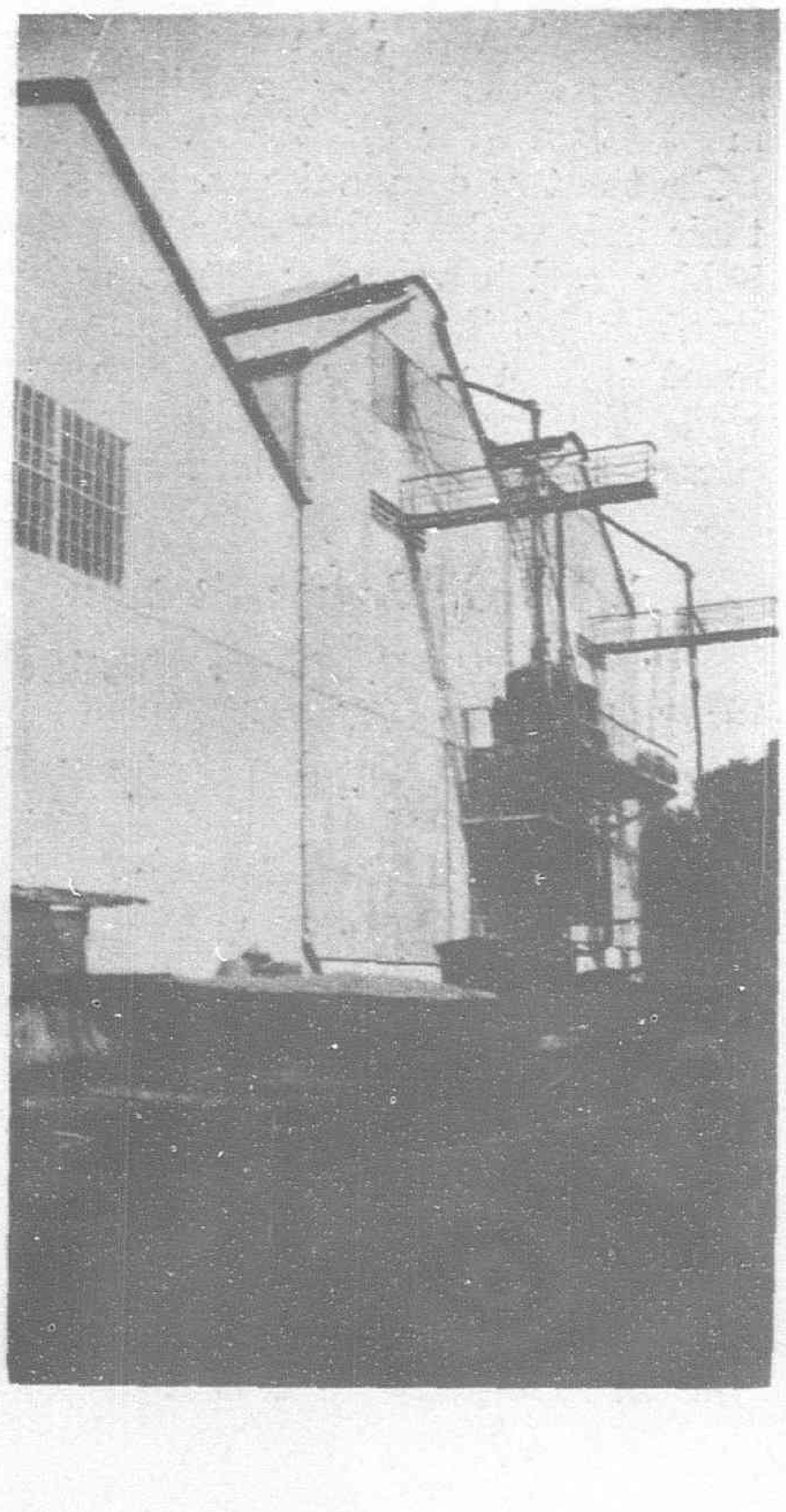
The Siam Electricity Co., Ltd.—This company was formed and incorporated in Copenhagen on December 27, 1898, for the purpose of acquiring the concessions, contracts and rights of the former companies and started its existence with a registered capital of £33,400.

In the course of 1900 and 1901 the fusion was completed whereby all the electric tramway and light undertakings in Bangkok were combined under the S. E. C.

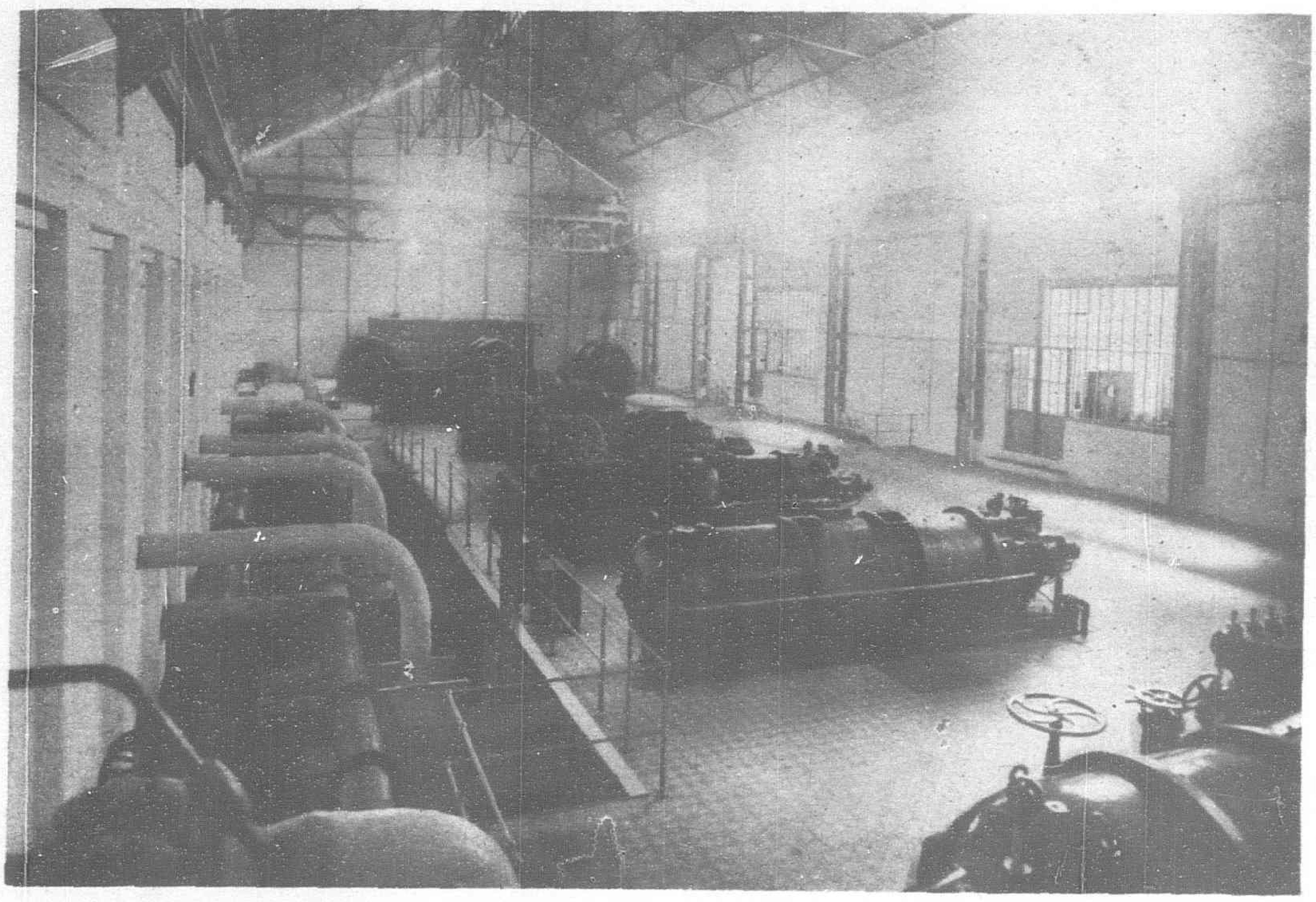
One of the first undertakings of the new company was the removal of the machinery of the two old tramway stations to the electric light station situated in the temple premises of Vat Lieb which latter station the company had acquired by virtue of its concession and where the company's activities are still carried on.



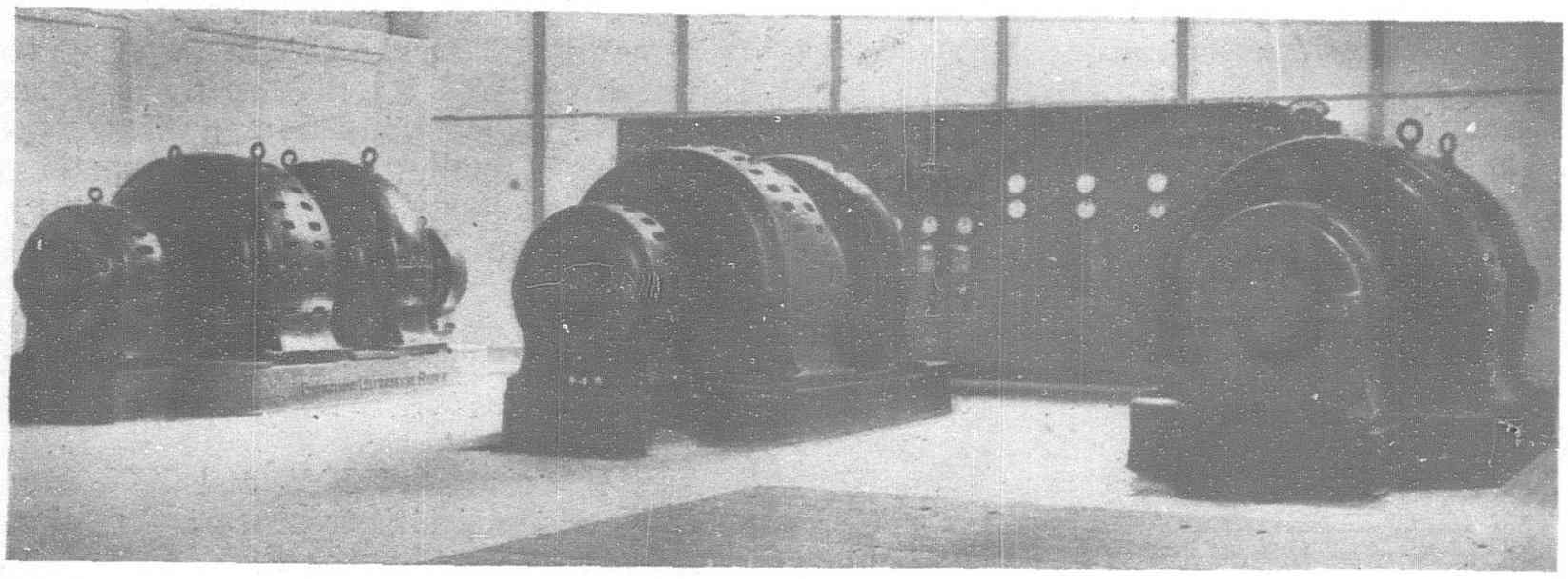




S.E.C. Power Station Husk Suction Plant



S.E.C. Power Station: General View of Engine Hall (from the A.C. Switchboard End)



Engine Hall Showing the 3 C.E.B. 800 kw. Motor Generators and Switchboard

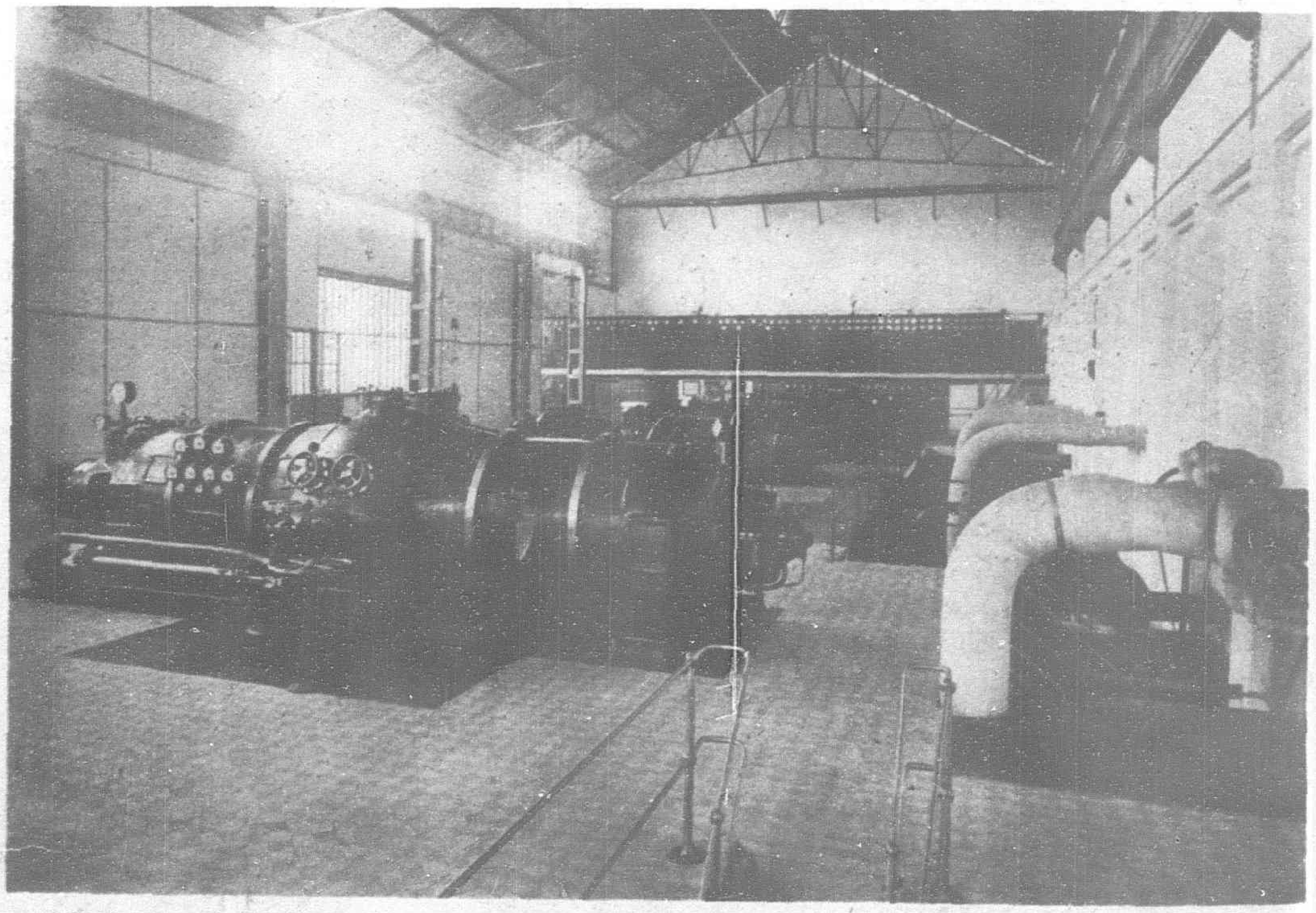
In the course of time the prosperity of the company grew and in 1907 it acquired a controlling interest in the Siamese Tramway Co., Ltd., a company started under royal charter in 1904 by Siamese princes and noblemen to operate another system of tramways in Bangkok.

The Siamese Tramway Co.'s power station was demolished and its management taken over by the S. E. C. and while the two companies each maintain their independent character, the shareholders and board of directors are to a great extent the same and the management is common for both companies, while the current is supplied from the power station of the S. E. C.

S. E. C. Power Station

The S. E. C. Power Station is situated in the Vat Lieb compound and a Klong connects the power station with the river (Menam). This connection is of great importance, as it provides the only channel through which all fuel is transported. The following is a short description of how the power station operates from the time the fuel enters in the Klong, until the current leaves the station for the different purposes in the town.

The main fuel used by the S. E. C. is paddy husk transported to the power station in boats each containing about 400 baskets (between 9 and 10 tons). Besides this, liquid fuel is kept in storage in case of shortage of paddy husk, and shortly two boilers will be erected provided with chain grates stoker for coal burning.



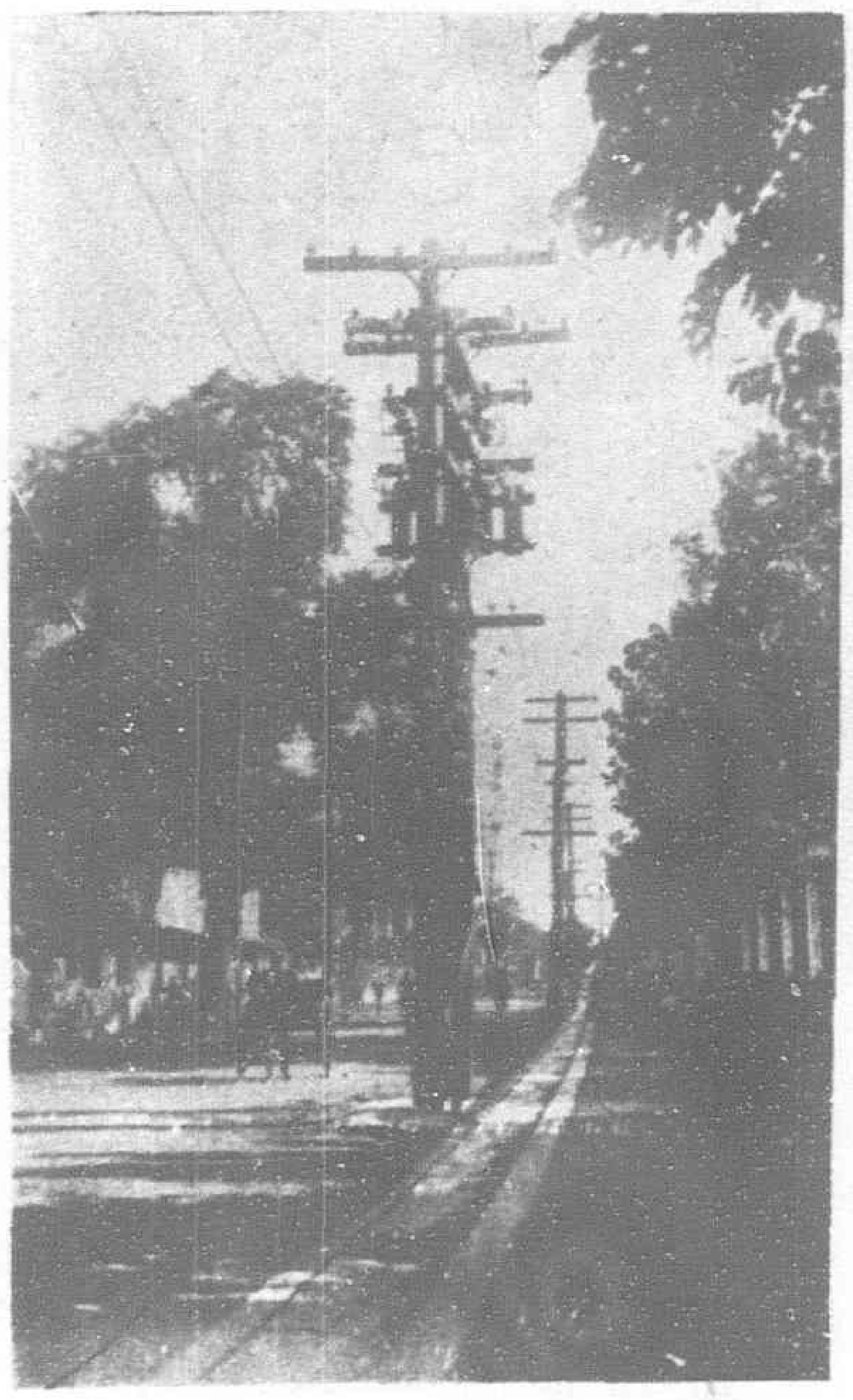
S.E.C. Power Station: View of Engine Hall Showing one of the 5,000 kw. Stal Tubo-Generators in the Foreground and the H.T. Switchboard in the rear

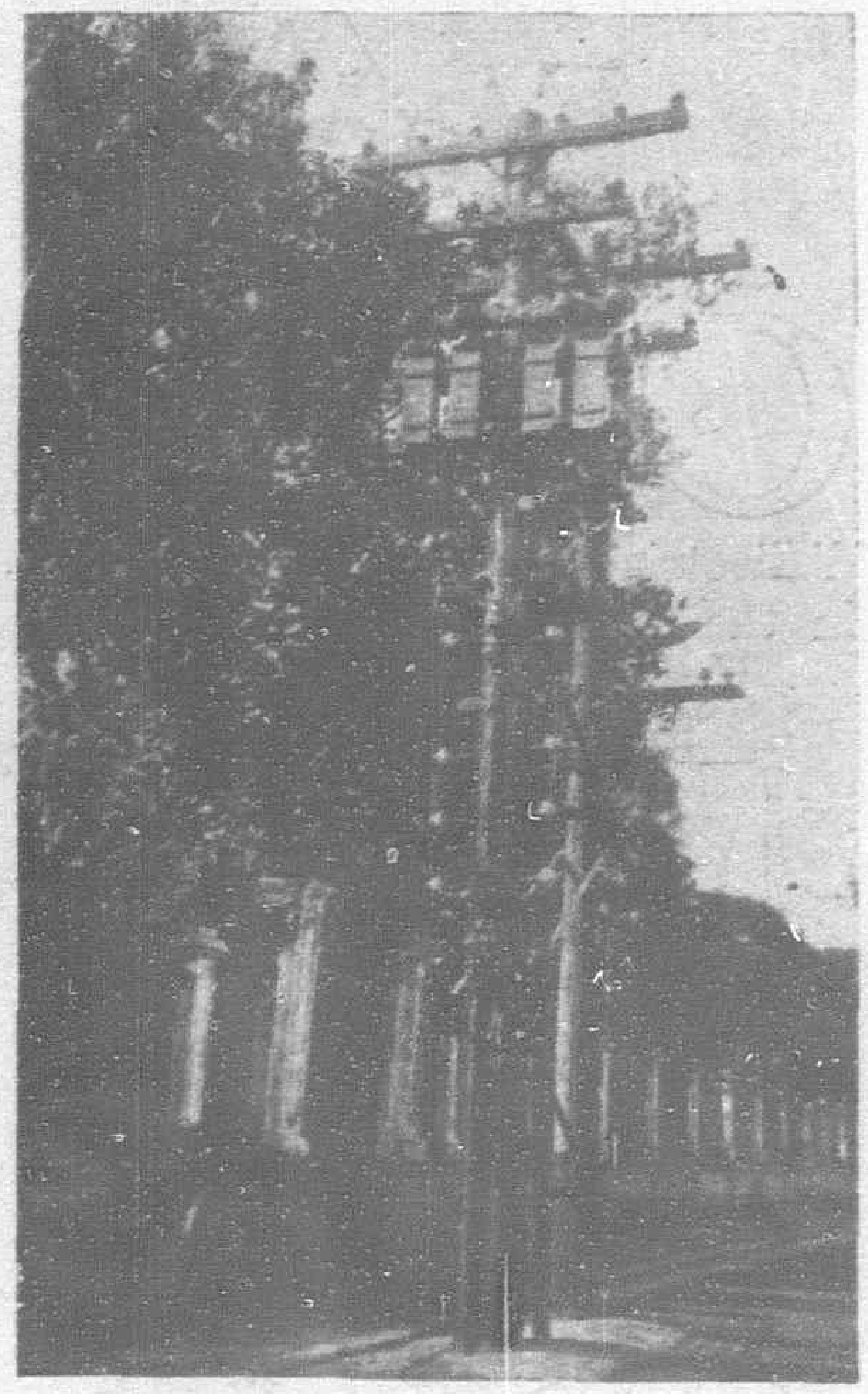
Boats are discharged by means of a suction plant, capable of discharging two boats in 45 minutes into the husk shed which has maximum capacity of 450 tons.

From the shed, husk is transported to the Babcock & Wilcox boilers by means of four screw conveyors. The boilers are equipped with grates the upper portions of which are fixed firebars, whereas the lower parts are movable, enabling the fuel to slide automatically over the grate. From the lower part of the grate the ashes drop into a water-drain discharging into the river.

The boilers are erected in two rows, one row consisting of four boilers and the other two. The maximum capacity of the boiler-room is 10 boilers. Each boiler is capable of producing 12,500 kg. of steam per hour at a pressure of 14 kg. per cm^2. They are provided with economizers and superheaters to increase the economy of the steam plant.

The feed pump plant for the boilers consists of three Weir turbine pumps, the capacity of each being 35,000 kg. per hour at a pressure of 15 kg. From the boilers the steam enters into the engine





S.E.C. Distribution System Left; End Pole for H.T. and Tramway lines close to the Power Station. Center, H.T. Line along Phya Thai Road. Right; Close up view of End Pole for H.T. and Tramway Lines

hall and goes to the turbines through the main steam pipes.

The engine hall is provided with six turbines of a total capacity of 16,500 kilowatt hours. The individual capacities of the turbines are as follows : 2 by 5,000 *stal*, 2 by 2,000 *stal*, 2 by 1,250 kilowatt hours A. E. G. Each turbine drives an alternator which generates current at a tension of 3,600 volts and 50 cycles. From the alternator the current is distributed by means of a switchboard through the different feeders. From these feeders current is supplied all over the town, the generating plant of the tramways and to the auxiliary service of the power station.

The water necessary for condensing the exhaust steam from the turbine is pumped up to the power station by means of a pump plant situated on the river, the capacity of which is 6,000 cubic meters per hour. The discharge of this cooling water goes back to the river through the ash drain or through the power station Klong. The windings of the alternators are also cooled by air passing through air filters of the viscous oil system.

The tramway current is generated by three electric motor generators (Construction Electriques de Belgique), capacity of each being 800 kilowatts. Each high tension synchronized motor of the group drives a dynamo which supplies the direct current of 550 volts to the feeders of the different lines through a special switchboard.

The development of the tramway has made it necessary to erect one substation at Bangkok Dock to supply current to the southern part of the tramway lines, just as a substation in Bang Na converts the alternating current into direct current for the Paknam Railway Co.

Distributing Net

As already mentioned, two kinds of current are generated at the power station.

(1) three phase alternating current, 50 cycles, 3,600 volts for light and power purposes.

(2) direct current, 550 volts, for tramway traction.

The current generated at the power station is brought into the town by means of high tension underground cables.

The cables supplying alternating current are connected to three high tension switch cabins, situated at different places in the town and thence the supply is transmitted by means of high tension overhead lines to which are connected the transformers which transform the tension from 3,600/100 volts for light purpose and 3,600/3 by 175 volts for power.

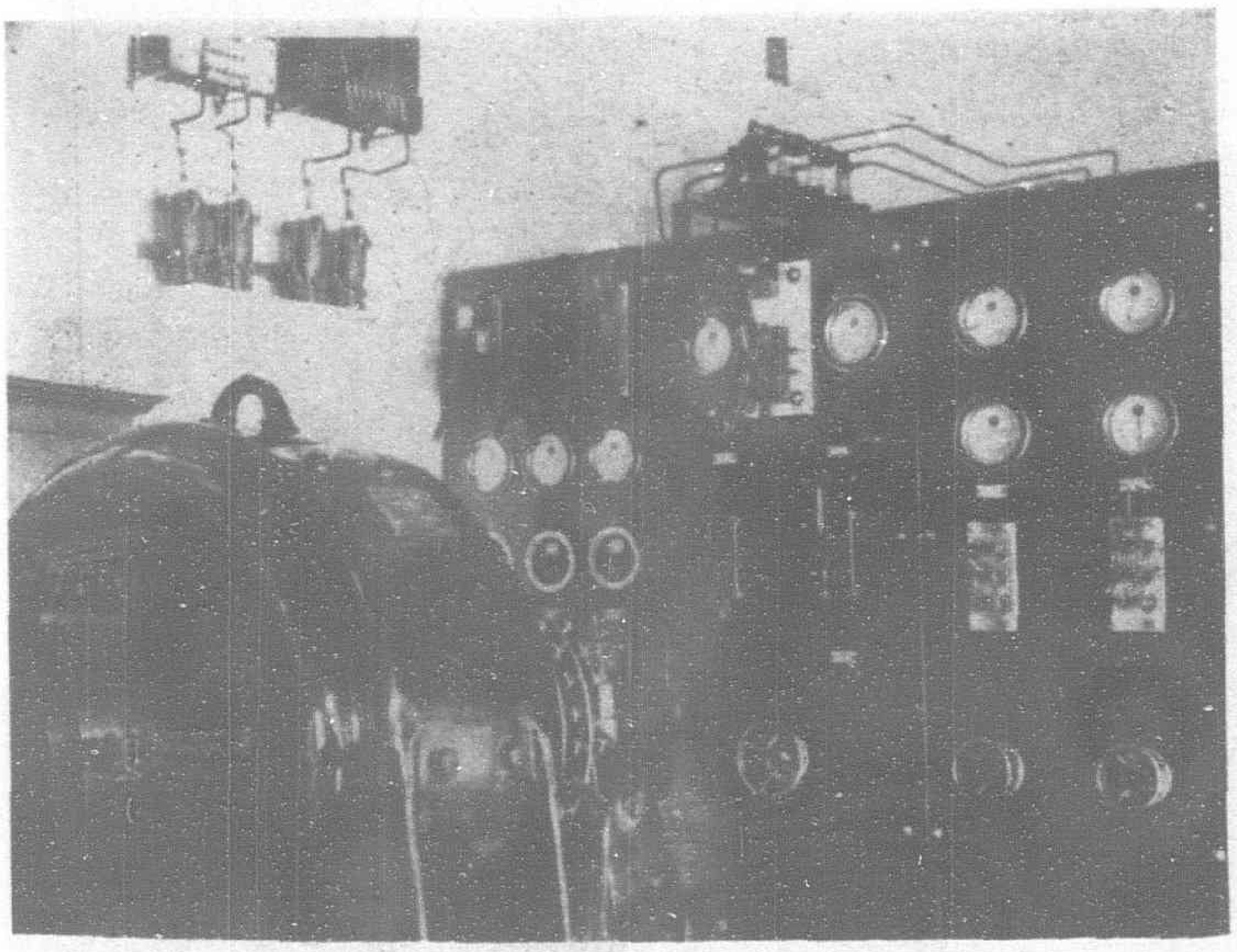
There are at present 12 high tension distributing feeders of which one feeder is especially used for public street lights, one feeder for Government customers, and 10 feeders for general distribution of light and power.

Practically all the high tension distributing feeders can be inter-connected either at the high tension switch cabins or by means of overhead line switches.

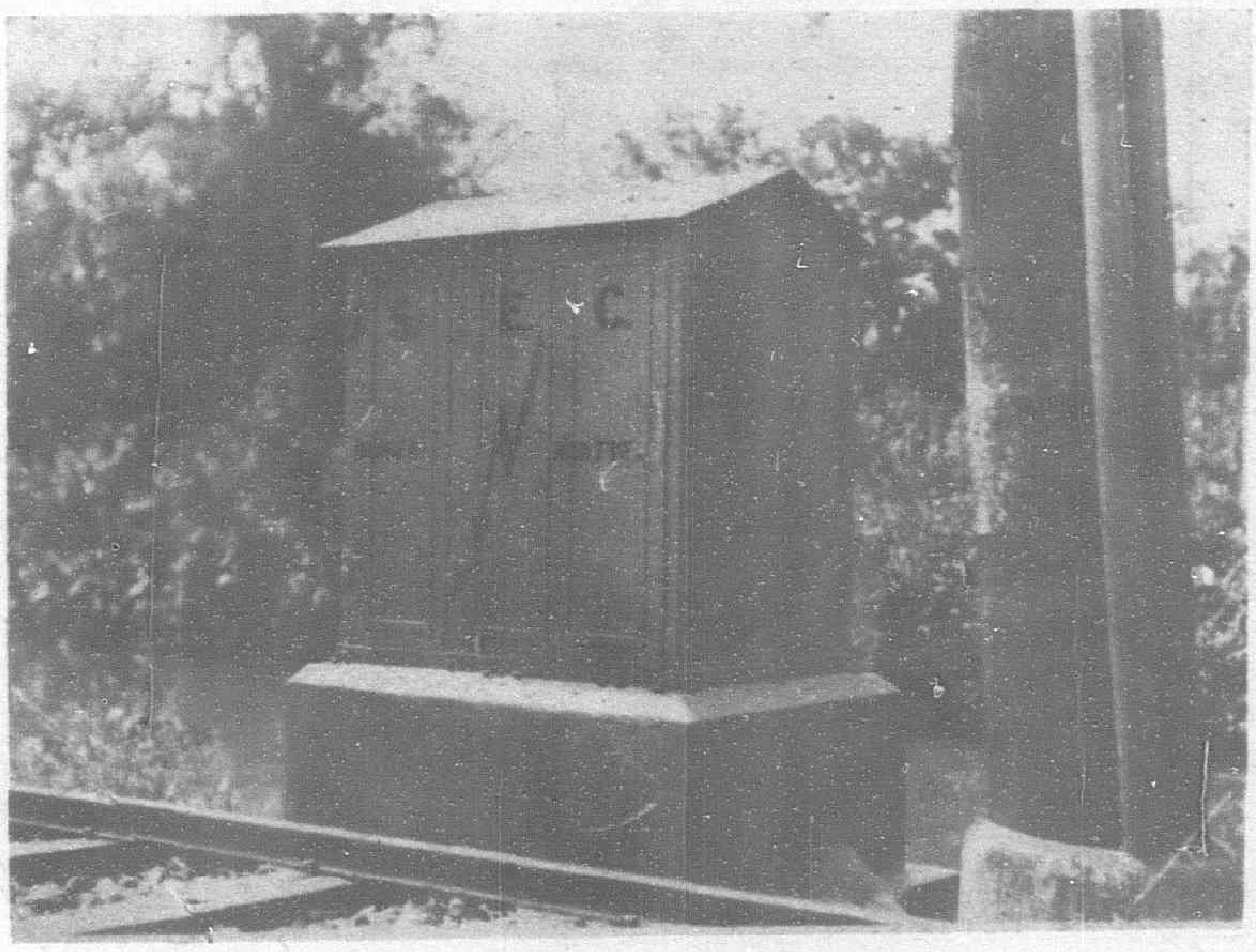
One high tension feeder is used to supply current to the Bang Na substation 12 km. from the Capital where A. C. E. C. cascade converters transform the current from 3,600 volts A.C. to 550 volts D.C. and supply current to the Paknam Railway Co., Ltd., which connects Bangkok and Paknam, a distance of about 21 km.

The high tension line which supplies current to the above substation is also carried through up to Paknam and supplies current to this small town.

(Continued on page 321).



Converter and Part of Switchboard in Bangkok Dock Substation



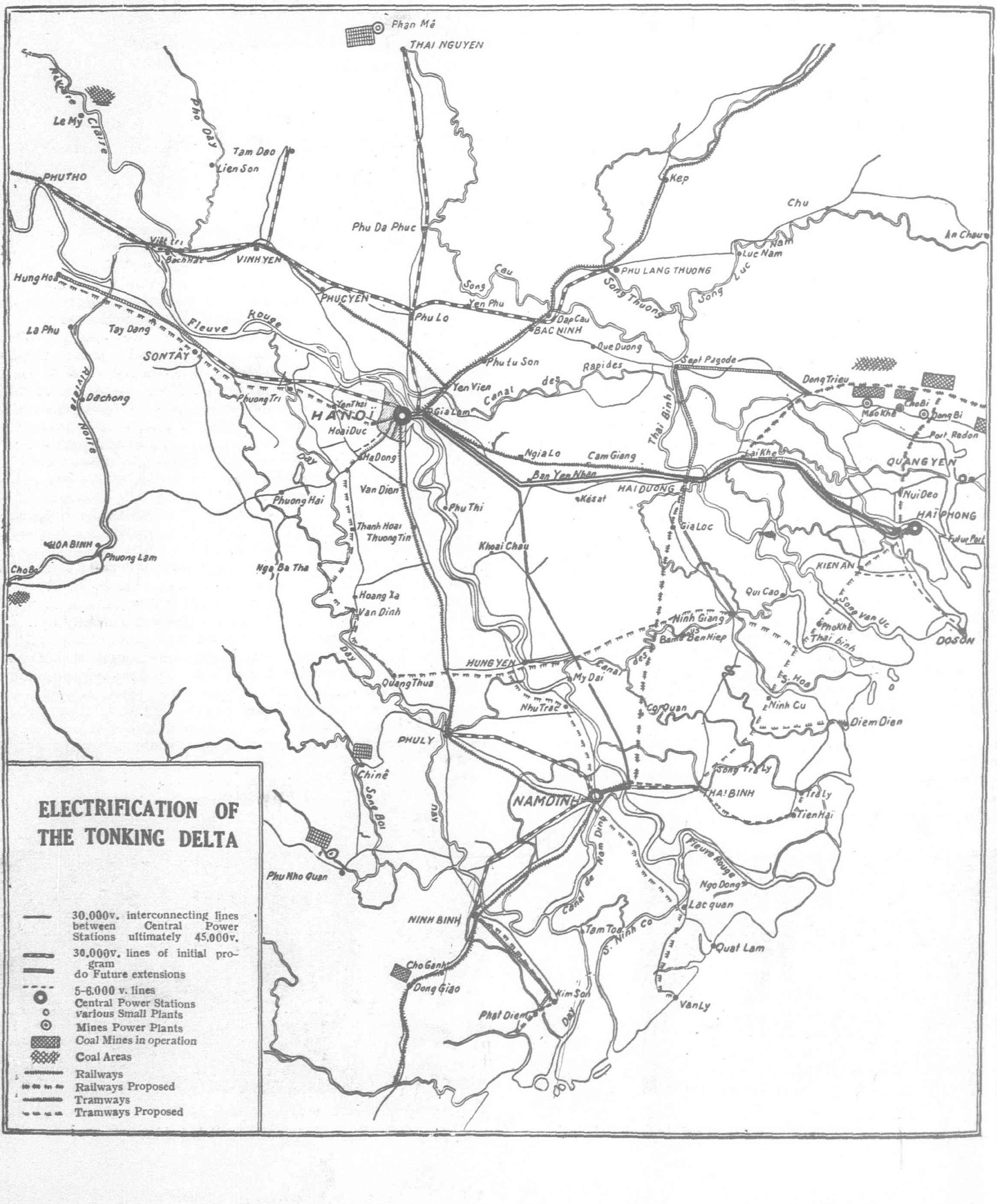
Automatic Switch Cabin

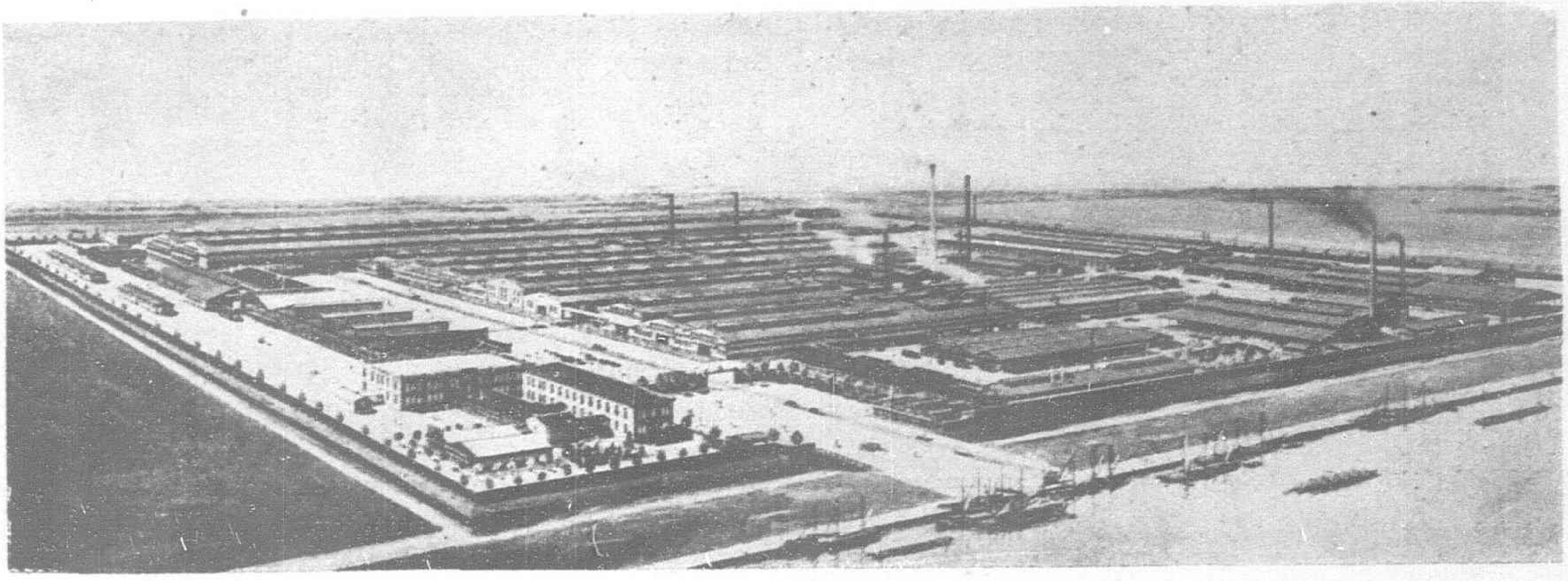
Electrification of the Tonking Delta

Construction work on one of the most important power systems in the Far East, will soon be started as the result of a recent contract entered into between the Indo-China Government and the Société Indo-Chinoise d'Electricité for the electrification of the principal cities and towns in the Tonking Delta. The contract has been submitted to the Minister of the Colonies for approval, and *L'Eveil Economique* gives the following outlines of its main provisions :—

1. Construction of a main power distribution system supplied from the central stations at Hanoi and Haiphong and interconnecting lines between Hanoi, Haiphong and Namdinh.

(Continued on page 321).





Sumitomo Electric Wire and Cable Works, Limited, Osaka, Japan

The Second Niihama-Shisakajima Submarine Power Cable*

By *J. R. PHEAZEY*

THE House of Sumitomo, an organization which is in the forefront of modern Japanese industrial and commercial enterprise, had its beginning in Japanese copper mining activities in 1690. The mines and, subsequently, the smelting plants were located at Besshi near the coastal town of Niihama on the island of Shikoku.

1899 serious floods occurred in the Besshi area. On this account the smelting operations were moved to the coast near Niihama whilst a new smelting plant was being built on a small island named Shisaka which lies about 23 miles from Besshi and some 13 miles from Niihama. All smelting operations were transferred to Shisaka Island in 1905.

Subsequently, the continuous development of all phases of copper producing led to a hydro-electric power plant being built to serve the Besshi mine area. This in turn induced the desire to transmit power which was being produced economically at Besshi to the smelting plants at Shisakajima and, incidentally, created the problem of providing a sure means by which some 13 miles of the waters of the Inland Sea could be spanned by a power transmission line.

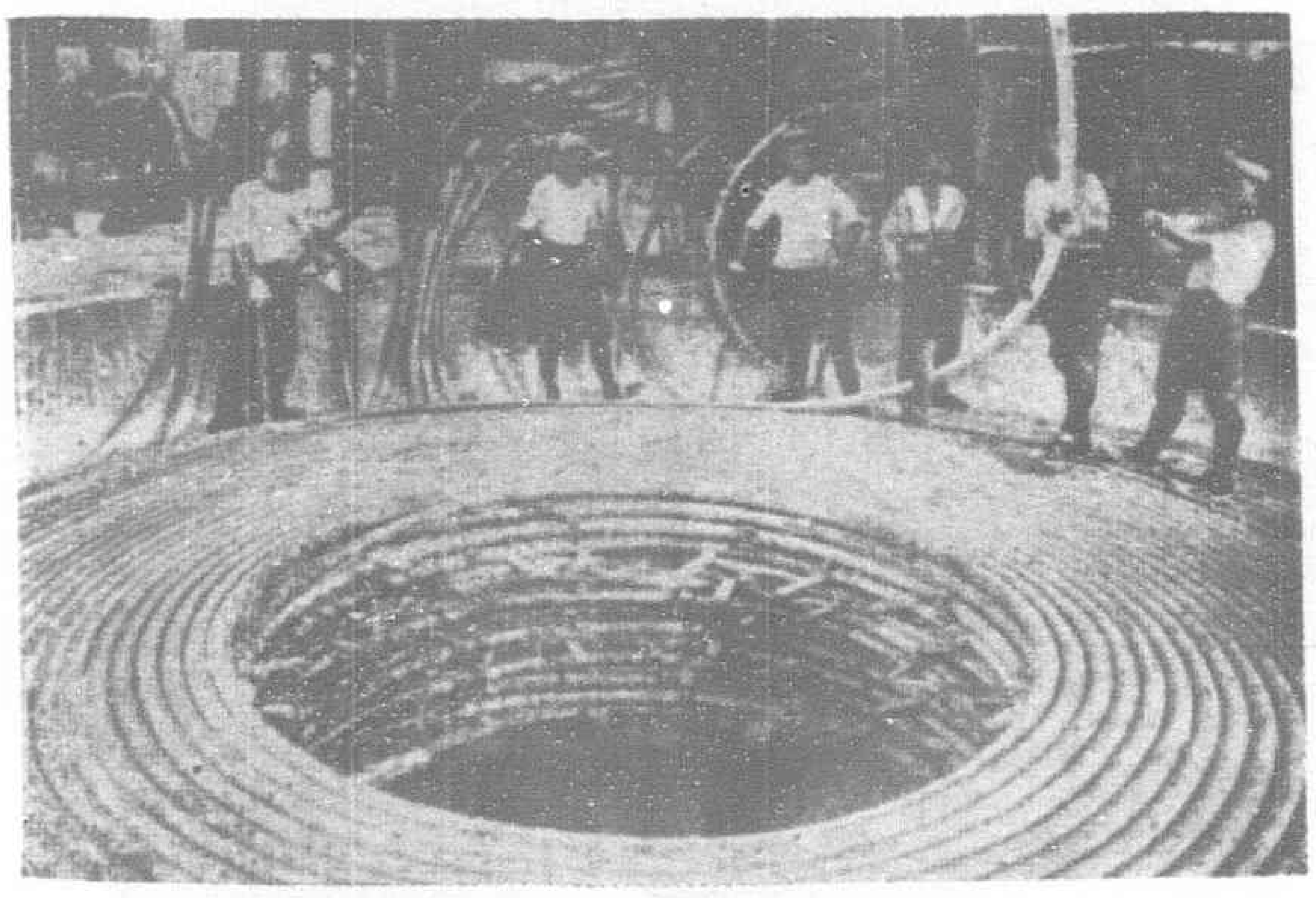
The solution of this problem was entrusted to the Sumitomo Electric Wire and Cable Works, Ltd., one of the manufacturing divisions of the Sumitomo organization. After comprehensive engineering consideration and a considerable amount of experimental work, this company designed and manufactured a 3-core paper insulated, lead covered and wire armored 11,000 volt submarine cable for the line from Niihama to Shisaka Island. Due mainly to the great difference in the requirements between paper insulated lead sheathed power cable and the more usual low power submarine cable for speech or signal transmission, it was to be expected that some difficulties would have to be overcome before the cable could be put into service. However, all difficulties were cleared and the cable was put into service in November, 1922. At this time it was believed to be the longest existing submarine cable of its type.

In 1929, it became necessary to transmit additional power to Shisakajima and due to the satisfactory performance of the 1922 cable it was decided without hesitation to lay a second similar cable. The order for the 11,000 volt submarine cable for the duplicate line was placed with Sumitomo Electric Wire and Cable Works, Ltd., in February, 1929, and the cable was manufactured, laid and put into service by September of the same year.

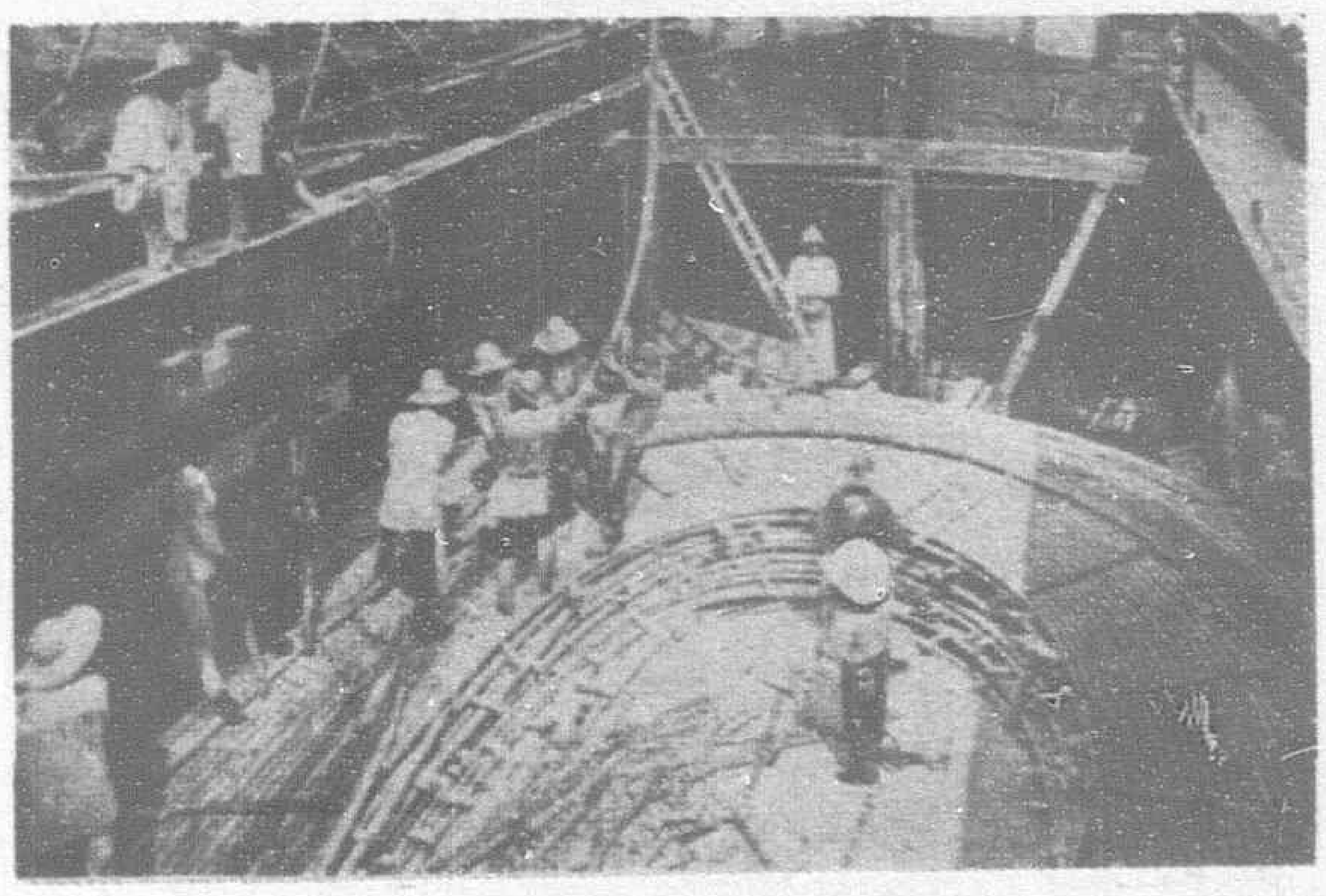
The design for the second cable embodies some interesting improvements. Thus the cable was double lead sheathed because this construction fully assures the complete impermeability of the envelope and, by improving the flexibility of the cable, facilitates handling both during the manufacturing operations and laying. The protecting armor was made to match the service conditions. At the Shisakajima end, where rocky conditions prevail, 2,000 meters of heavily armored shore end type cable were used; for the balance of the line, the armoring was made about 30 per cent lighter than that used for the first cable since the sea-floor and conditions at the Niihama landing permitted this economy.

Special attention was directed to minimizing damage to the cable and interference with the service which might come from fouling of the cable by ships' anchors. To limit the extent of water penetration in the event of the sheaths being punctured by any such accidents, the cable was plugged at every 500 meters of its length. In addition it was carefully laid in a zig-zag path on the soft sea bottom so that a spare length for repairs is immediately available at all times and any necessity for disturbing the cable after it has become imbedded in the sea floor, except for a relatively short length on each side of the fault, is removed. This method of laying has the added advantage that only one joint is normally required in clearing a fault whereas two joints are necessary whenever a new length is inserted.

The 1929 cable contains four pilot conductors for use in connection with fault indicating apparatus and telephones. The arrangement of these conductors is similar to that used in the earlier cable except for refinements in details. The more usual use of insulated round conductors located in the fillers or wormings between the sector-shaped power conductors was considered and abandoned on account of the increase in the size and cost of the cable which it entailed. An interesting alternative which was examined was the insertion of an insulated pilot conductor in the center of the cable for a



Lengths of 1,000 Meters of Cable Placed in Tanks at the Factory for Testing and Temporary Storage



The Hold of the "Taisho Maru" During the Loading Operations

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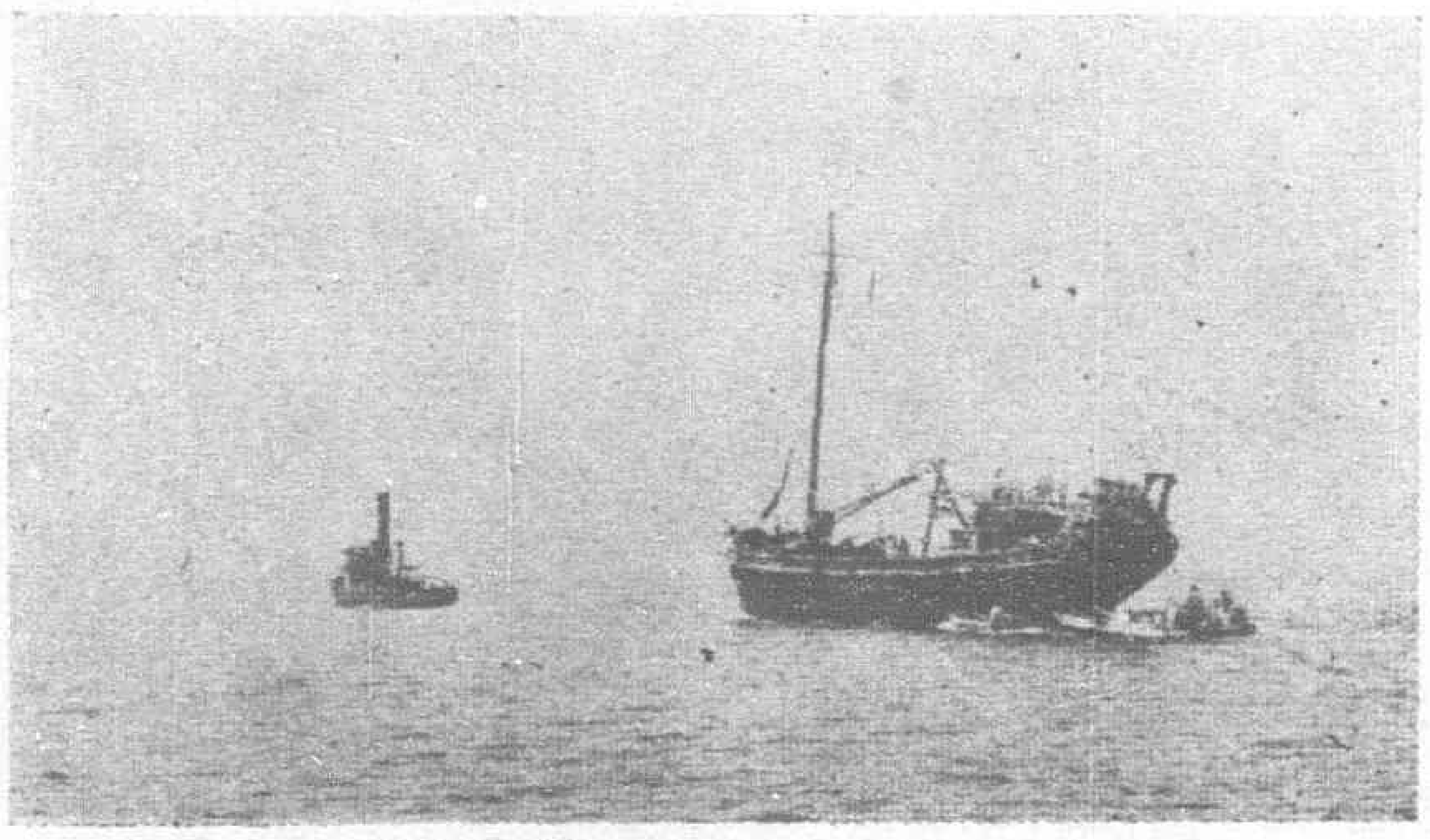
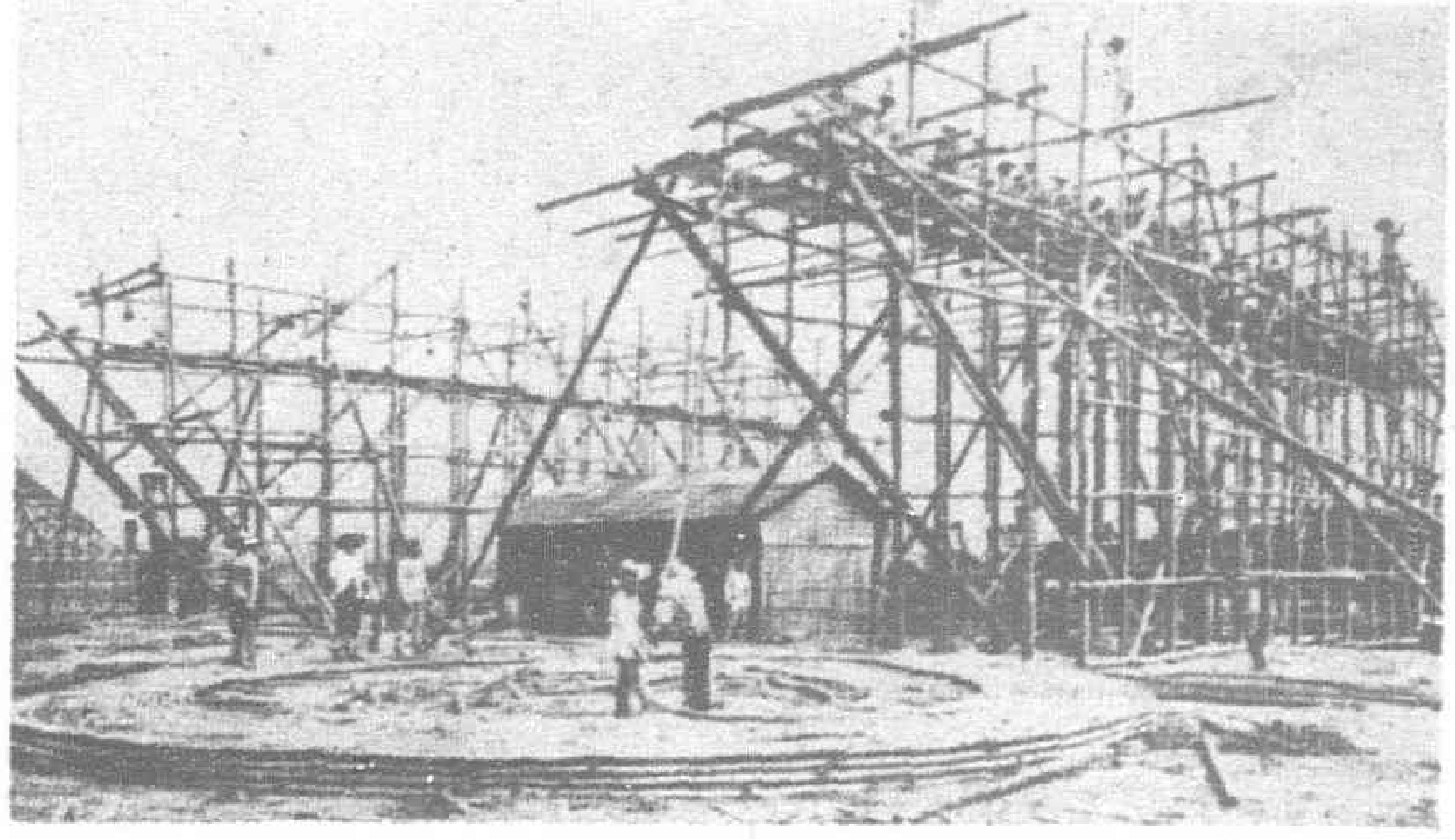
*From *Electrical Communication*

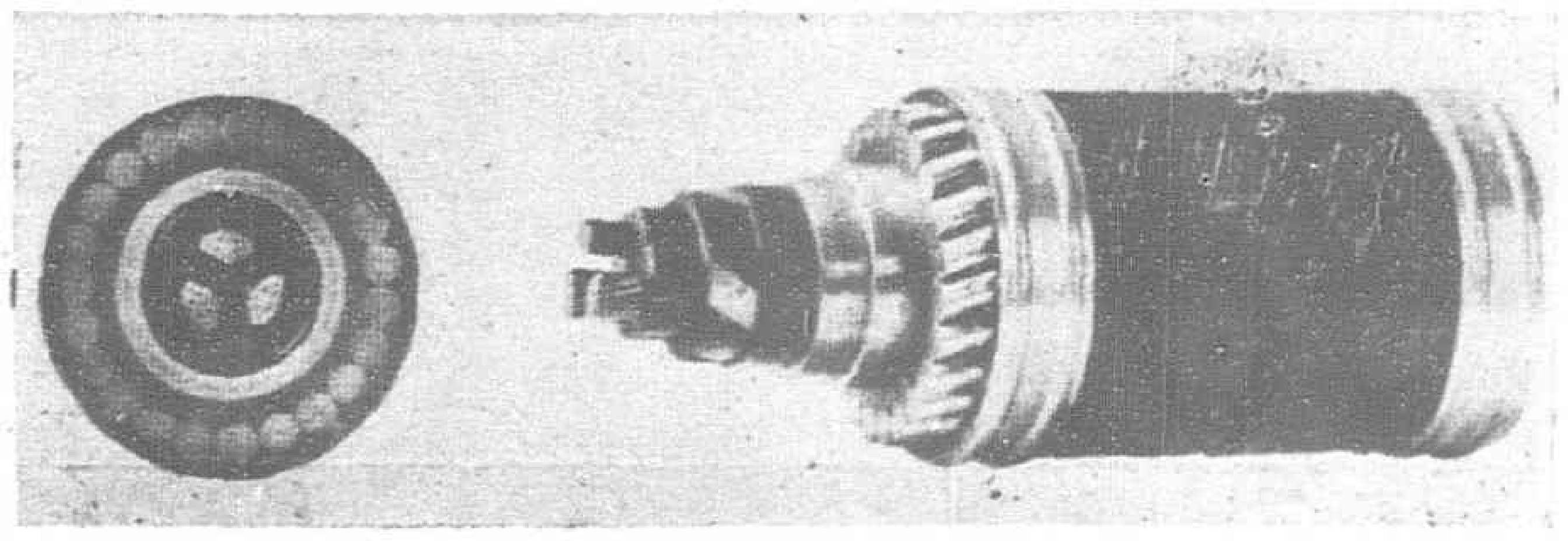


Paying Out Cable in the Inland Sea



Running the First Section of Cable to the Boat After Joining at the Factory

certain distance at both ends of the complete line. The capacity between these end wires and the heavy power conductors would have been utilized to complete one side of the circuit and an earth return would have formed the other side of the circuit. This arrangement would have given only one telephone circuit and a poor standard of fault-indicating service and was therefore rejected. The scheme actually used consists of four copper tapes spirally applied to the cable so as to occupy symmetrical positions in close proximity to the inner cable sheath and to be relatively lightly insulated therefrom. Thus, in the event of the cable sheath being damaged and punctured, the sea water will quickly penetrate the lighter insulation of these conductors and so through the operation of signals in the substations, will give a warning of the fault long before the main power conductors are reached or break-down occurs. This feature is also of great value in connection with the check tests which are made repeatedly during the manufacture, laying, and jointing of the cable. In addition to their use for fault indicating, the four pilot conductors provide two telephone circuits through suitable terminal apparatus which is located in the substations. On this account the pitch of the copper tapes is specially adjusted with respect to that of the power-carrying conductors and the conductors diametrically opposite in the cable are used for the telephone services in order to minimize inductive interference. The arrangement and circuits of the fault-indicating apparatus and telephone equipment at the substations is as shown in the accompanying schematic.

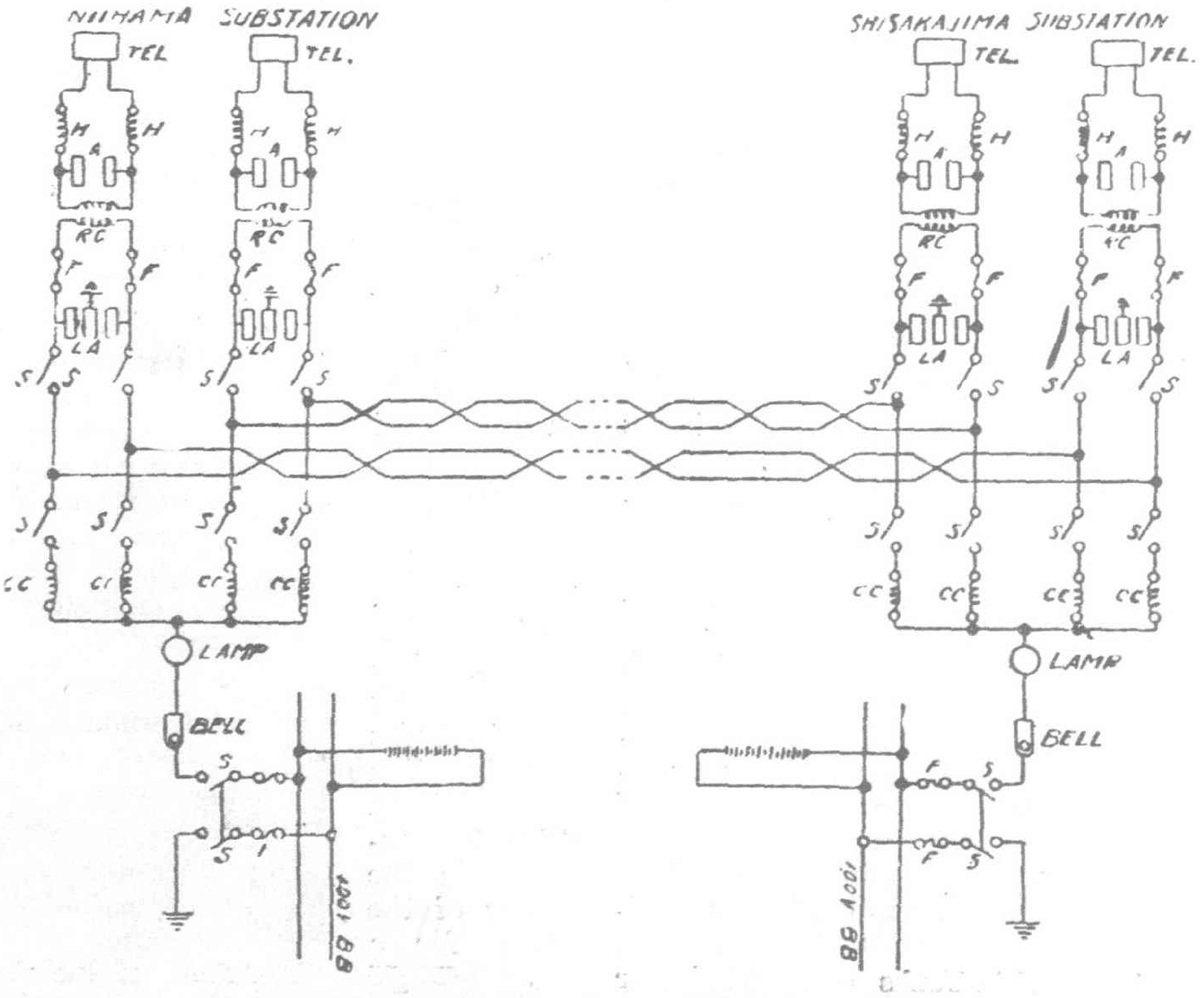


Shore End Cable—Telescoped End and Cross Section

Another feature of the cable is the complete absence of joint boxes. For the jointing of factory lengths and also for the joint made at sea, a special joint was developed which permitted the use of lead covering sleeves, approximately of the same diameter as the cable sheath. The use of this construction in cable operating at 11,000 volts is of particular interest. To adequately protect and strengthen the joint mechanically the jointing of the jute bedding, armor wires and jute serving was distributed over a length of some twelve meters and a suitable security binding was applied overall.

The manufacture of the cable was carried out in two parts. For the first section, factory lengths averaging 1,000 meters long were made, tested, and afterwards jointed together to give a length of 11,000 meters. This was shipped to the job and laid from Shisakajima, whilst the second section was being completed at the factory. The second section was 10,000 meters long and was made up in a manner similar to the first. This was sent out to the job in the same boat which had carried the first section and the single sea joint which connected the two sections was made with the first section in the sea and the second section still on board. Subsequently, the second section was laid and landed at Niihama. Inasmuch as it would not have been an economical proposition to engage a regular cable laying vessel for the work of laying this cable, the difficulty was overcome by adapting a small cargo carrier to the service. This adaptation was carried out with no little ingenuity by the Japanese engineers of the Sumitomo Installation Staff and not even the smallest difficulty was experienced in practice.

With the exception of the lead used for the cable sheaths, all the materials used in the manufacture of the Niihama-Shisakajima cable, including the copper, were produced in Japan. The cost of hydro-electric power transmitted from Besshi compared with the estimated cost of power generated at Shisakajima is such that the cost of each of the two complete overhead and submarine power transmission lines from Besshi to Shisakajima can be recovered within a few years. Incidentally, at the time of completion of the second Niihama-Shisakajima contract, the aggregate length of submarine power cables made and laid in Japan by the Sumitomo Company was more than 56,000 meters. These cables all remain in efficient operation and range from 2,300 volts cable to high tension cable operating at 22,000 volts.



Schematic of Fault-Indicating and Telephone Circuits

Japan's vigorous progress in modernizing the country with almost incredible speed is paralleled in the case of the electrical industry, by Sumitomo Electric Wire and Cable Works, Limited. Even while the second Niihama-Shisakajima cable was being laid, the Sumitomo Company was actively engaged in installing new research, manufacturing, and testing equipment which will still further increase its ability to meet modern requirements for underground, submarine, and power cables.

Appendix.—1929 Niihama-Shisakajima Cable—General Description

TYPE.—3 power conductors plus 4 signal

conductors. Paper insulated, impregnated, double lead-sheathed and single wire armored cable for 11,000 volts working pressure.

Copper Conductors.—Power conductor= one 3.6 mm. dia. wire plus fifteen 1.8 mm. dia. wires laid up into sector-shaped strand. Area= 50 square mm. Signal conductor=tape 8 mm. wide by 0.32 mm. thick.

Dielectric Thickness.—From core to core =7 mm. From core to signal conductor=6.5 mm. From signal conductor to sheath=1.5 mm.

Pure Lead Sheath.—Inner Sheath—1.9 mm. thick. Outer Sheath—2.1 mm. thick.

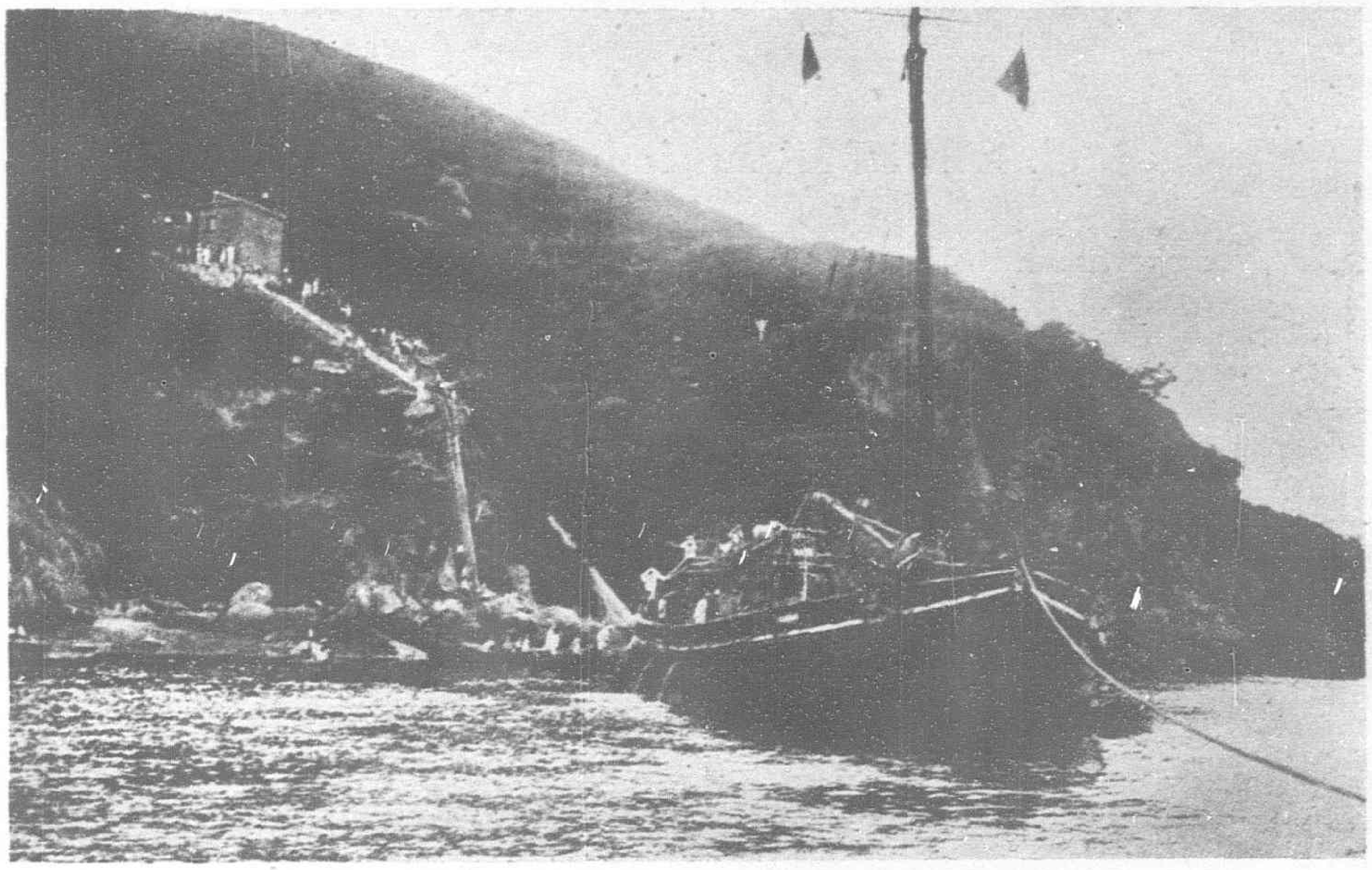
Single Wire Armor.—Shore End Cable =twenty-three 8 mm. dia. galvanized steel wires. Sea Cable=twenty-nine 6 mm. dia. galvanized steel wires.

Diameter Overall.—Shore End Cable= approx. 76.3 mm. Sea Cable=approx. 72.3 mm.

Weight per kilo.—Shore End Cable= 21,422 kilograms. Sea Cable=18,692 kilograms.

Factory Pressure Tests.—Each 1,000 meter length between: Cores and Sheath—25,000 V. A. C. for 10 min. Tapes and Sheath—1,000 V. A. C. for 10 min. On 11,000 meter and 10,000 meter jointed sections between cores and sheath : 16,500 V. A. C. for 10 minutes.

Pressure Test After Laying.—13,750 V. A. C. for 10 minutes between cores and sheath.



Landing the Shore End Cable at Shisakajima

Electrification of the Tonking Delta

(Continued from page 318).

2. Construction of a main transmission net to supply centers not yet electrified and to connect up with the main net those centers already supplied from small local plants.
3. The above nets will be supplied by power from (1) the Central Power Station at Haiphong and (2) from the new 40,000 kw. power station now being erected by the S.I.E. at Hanoi, which is sufficient to supply all the power requirements of the Delta.

   The contract provides that the Government becomes a shareholder in the S.I.E. with representation on the Board of Directors and in its management.
4. The contract calls for the completion of the program within five years according to the following schedule.

   1st Period.—Transformation of the Hadong transmission system: electrification of the towns of Phu-Ly, Ninh-Binh, Thai-Binh and Hung Yen : hooking up the Hanoi and Namdinh power stations.

   2nd Period.—Connect Bac-Ninh, Dap Cau and Phu-Lang-Thoung with the Central Power Station at Hanoi and link up Hanoi with Haiphong bringing Haiduong into the main net.

   3rd Period.—Extension of net to supply the towns of Phue-Yen, Vinh-Yen, Tam Dao, Thai-Nguyen and Sontay.

   4th Period.—Extension of net to supply Vietri and Pho-Tho.

The above is merely the outline of the essential features of the main scheme which will ultimately be expanded to embrace all the other centers of the Delta. The main system represents a length of over 600 km. of high tension transmission lines covering the Delta with a net from which the secondary lines will supply electricity for operating smaller stations, mining concessions, pumping and other industrial plants. Alternating, three phase current at 30,000 v. will be fed into the main net from the central power stations, and stepped down to 208 v. for operating motors and 120 v. for lighting.

Bangkok's Electrical Supply

(Continued from page 317).

The tramway distributing feeders which are 10 in number also leave the power station in underground cables and extend to various places in the town deemed most suitable as points of connection with the tramway sections.

Practically all the tramway sections are supplied with current generated at the power station, with the exception, however, of three sections in the southern part of the town which receive current from the Bangkok Dock substation where two convertors of 360 kw. (C. E. B.) generate the necessary D.C. supply.

'Phone to Japan

In Berlin a few days ago trial conversation took place with Japan for the first time in *both* directions. *One-way* wireless telephony service has been in use for some time.

At the moment conferences are being held between The German Post Office, the Transradio Co. and the Japanese Communications Office, concerning the arrangements for a permanent telephone service to Japan. Still further trials must be made however to determine the technical conditions necessary for a reliable service and if these trials are successful, the question of the opening of this telephone " line " will be at once acute. On the German side use is being made of the short-wave transmitter in Nauen built by the Telefunken Company.

The first trial in Berlin was attended by the representations of the Japanese press in Germany, and several Japanese delegates to the World power conference, among them being Dr. Inada from the Japanese Communications office in Tokio. The Japanese embassy in Berlin also sent a representative.

According to reports from Japan, speech was clear and easy to understand. It is only natural therefore that the Japanese living in Berlin are enthusiastic about this trial as it shows them the possibility of talking to their friends at home over the telephone.

Age of Alloys

A Brief Discussion of the Benefits of Alloys Particularly Copper Steel

For ages, man has known and practised the art of alloying metals. This is evidenced by some of the tools used in cutting the mammoth stones for the Pyramids. Analysis indicates that these tools were made by alloying copper with tin—and we at once recognize the metal as bronze. It served the Ancient Egyptians well. Other equally interesting instances could be cited from the time of Tubal Cain down to the present.

In this era, the principle of alloying metals has been widely applied to the improvement of steel, until the combinations of mixtures which have commercial value, are legion. The Age of Steel has become the Age of Alloys. Through this blending of the properties of the more noble metals, it is possible to impart valuable qualities to iron and steel for specific purposes.

In the entire metallurgical field this importance of alloys is recognized ; railroad rails contain a certain percentage of carbon for strength ; automobile axles are alloyed with vanadium for toughness ; steel for airplane construction is alloyed to meet the exceptional strain made upon it ; cutlery steel is alloyed to give cutting edge and temper ; the bank vault door is alloyed to give it resistance to puncture or drilling ; armor plate for the battleship is alloyed to resist impact and piercing projectiles ; steel for electrical uses is alloyed to resist current losses ; and in a host of other ways the fact of the benefit of alloys is accepted and acknowledged. In exactly the same way—

Steel is Alloyed with Copper to Resist Corrosion

This is a scientific fact, long since removed from the realm of mystery or conjecture.

Keystone Copper Steel stands out as one of the greatest achievements in the whole array of valuable alloy discoveries, carrying with it the promise of preserving steel from the ravages of corrosion.

Recent scientific developments resulting from long research prove Keystone Copper Steel to be exceptionally valuable for resisting rust. The conflict of centuries against corrosion has been waged courageously, and it seems now, successfully.

Constituent elements often lose their identity in the alloying process, and the resulting mixture exhibits new and unexpected qualities. For example, observe the group of fusible metals—Bismuth, Tin and Lead. The fusion point of each of these is about 500°F. but if we alloy these three elements in the proper proportion the melting point would be reduced to below 200°F. The alloying has wrought the change.

When copper is added to molten steel, the copper goes into solution and diffuses through the mass (just as sugar goes into solution and diffuses through a cup of coffee) thereby forming an alloy in which the two ingredients are intimately combined. In fact, a new metal is formed, just as copper and zinc are in the same manner combined to form brass. When copper is alloyed with steel, although its identity as copper may be lost, its ability to withstand atmospheric corrosion is retained, and this benefit is imparted in a large degree to the steel. The volume of copper used in making this alloy is not great but the result produced in very important. Like the salt in food and the sugar in coffee, its presence in the right quantity or its absence, makes or mars the whole result.

Able scientists, metallurgists and engineers have proved conclusively by actual exposure tests and otherwise, that to Keystone Copper Steel produced by a proper blending of copper and well made steel, there has been imparted to a remarkable degree the corrosion resisting properties of pure copper. They have gone boldly on record on this subject, in plain and positive terms. Some of their findings are briefly quoted below :

Committee A-5 American Society for Testing Materials. (after 11 years of carefully conducted tests.)

> " We have now reached a point where we may definitely conclude that copper bearing material shows marked superiority in rust-resisting properties as compared to non-copper bearing metal of substantially the same general composition... under atmospheric exposure."

Dr. Wm. H. Walker, Professor of Chemical Engineering, Massachusetts Institute of Technology

> On weather corrosion : " I do not know of a single instance in which copper-bearing steel has not outlasted every other type of commercial iron or steel available."

E. A. Richardson, Chemist, Cleveland, Ohio. L. T. Richardson, Chemical Engineer, New York City.

> " Copper-bearing steels are decidedly superior to pure iron, steel, or charcoal iron. The addition of copper to pure iron increases its resistance to corrosion but to no such extent as similar additions to steel."

O. W. Storey, Metallurgical Engineer C. F. Burgess Laboratories, Madison, Wis.

> " My own data collected from corroded fence wire also show that copper steel is much more resistant to corrosion both in an acid atmosphere and in a comparatively pure atmosphere."

Samuel L. Hoyt, Associate Professor of Metallography, University of Minnesota

> " The general conclusion which it believed may be drawn from this exposure test is, that the so called copper-bearing steel, in which the copper content is about .20 per cent to .25 per cent, offers the greatest resistance to corrosion of the common sheeting materials."

Dr. M. E. McDonnell, Chief Chemist, Pennsylvania Railroad Company

> " Our tests...together with the obvious outcome of the American Society for Testing Materials Pittsburgh test, led the Pennsylvania management in 1919 to adopt copper bearing steel for all sheet steel to be used in cars."

J. J. Tatum, Superintendent Car Department, Baltimore and Ohio Railroad

> " It is felt that the investigation outlined...is conclusive and convincing evidence that steel with a small content of copper will give much longer life in car equipment."

J. L. Beven, Vice-President, Illinois Central Railroad

> " The body of every car (used in electrified suburban service) is built entirely of copper-bearing steel."

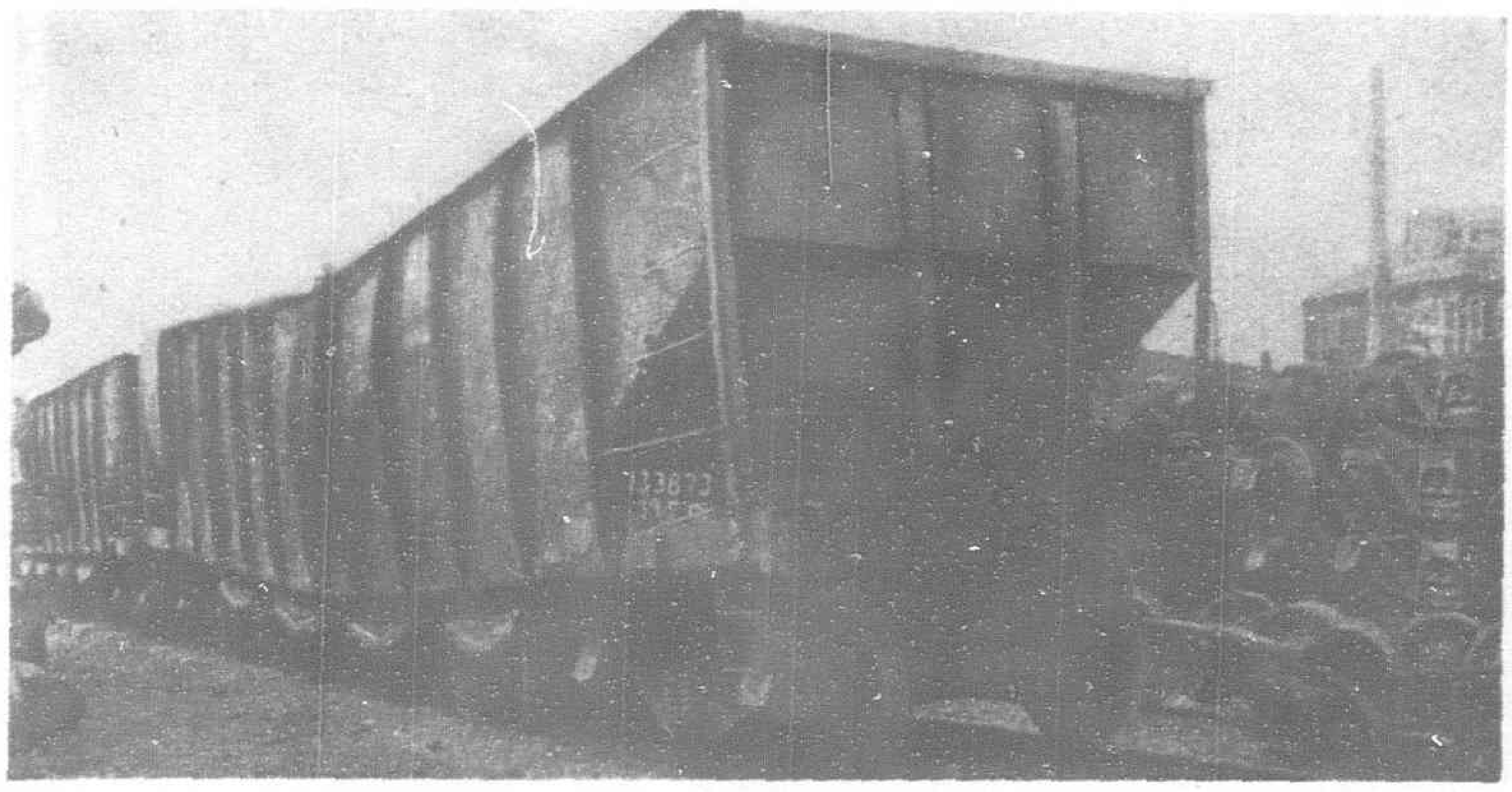
The illustrations accompanying this narrative show many of the imporant uses to which Keystone Copper Steel has been put with great success.

It is the safe, practical and economical material to use—

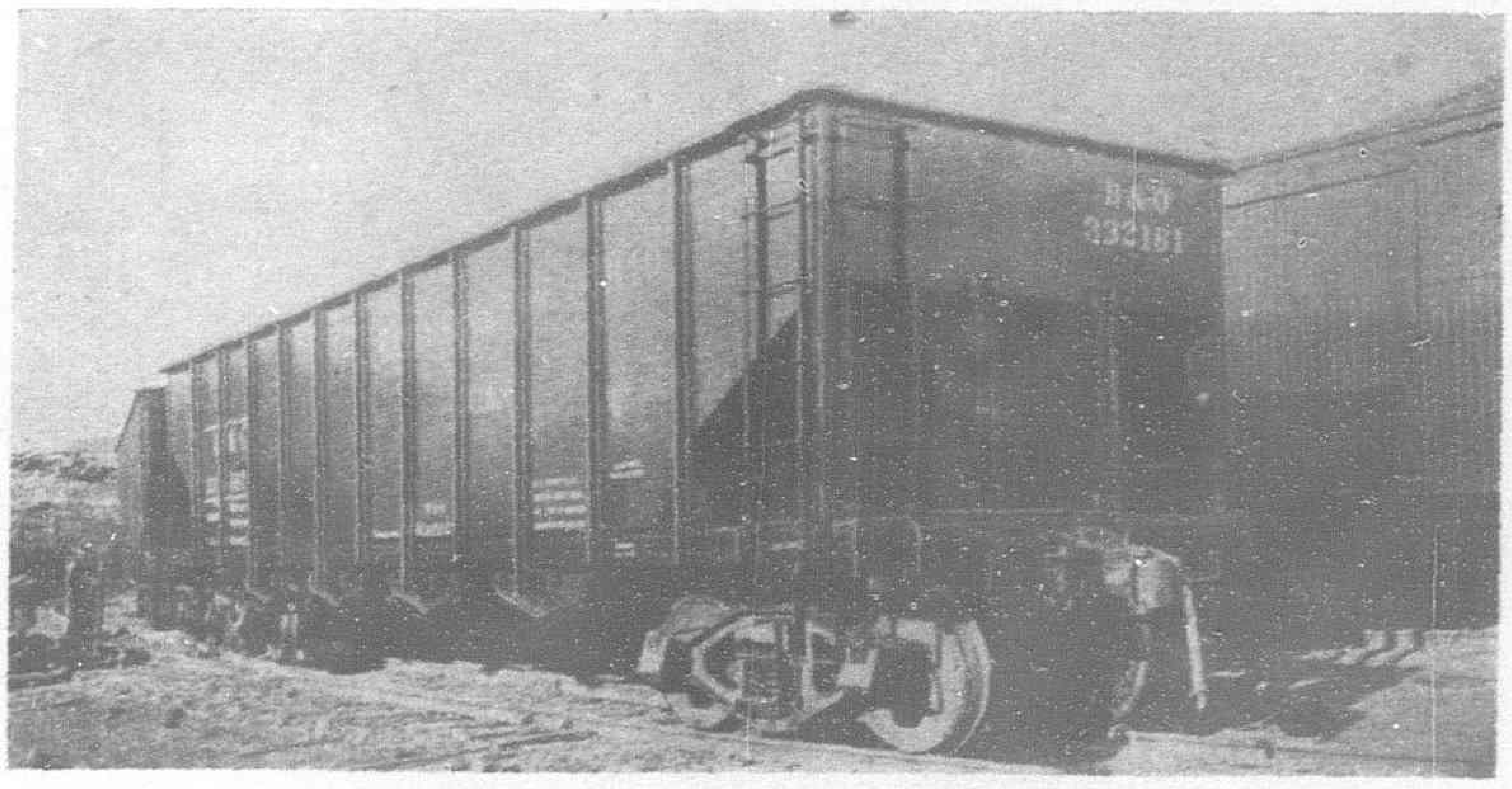
For roofing and siding, for cornices and skylights, for culverts and flumes.

For cars and car roofs, for stoves and refrigerators, for boat plates and metal lath.

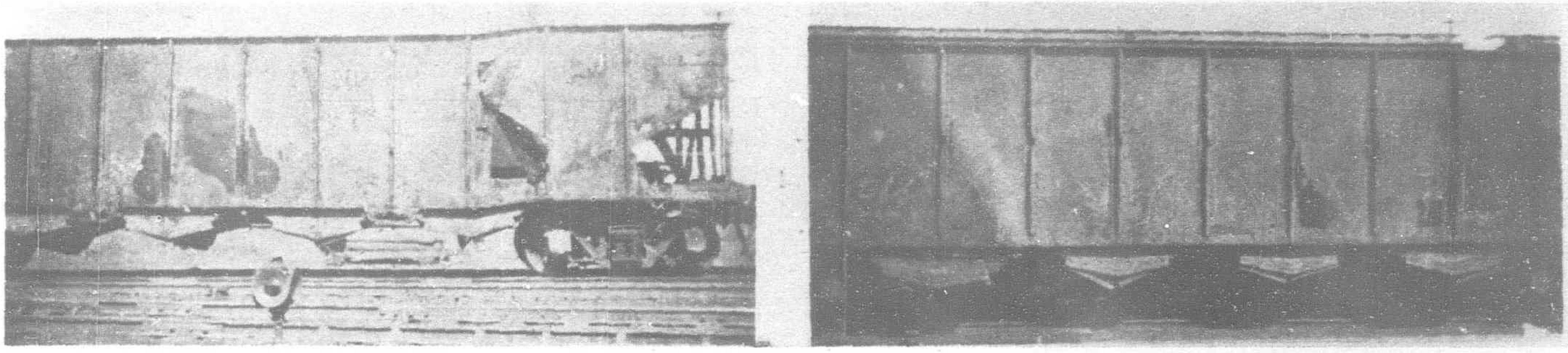
For pipe in service under many adverse circumstances ; and for many other purposes.



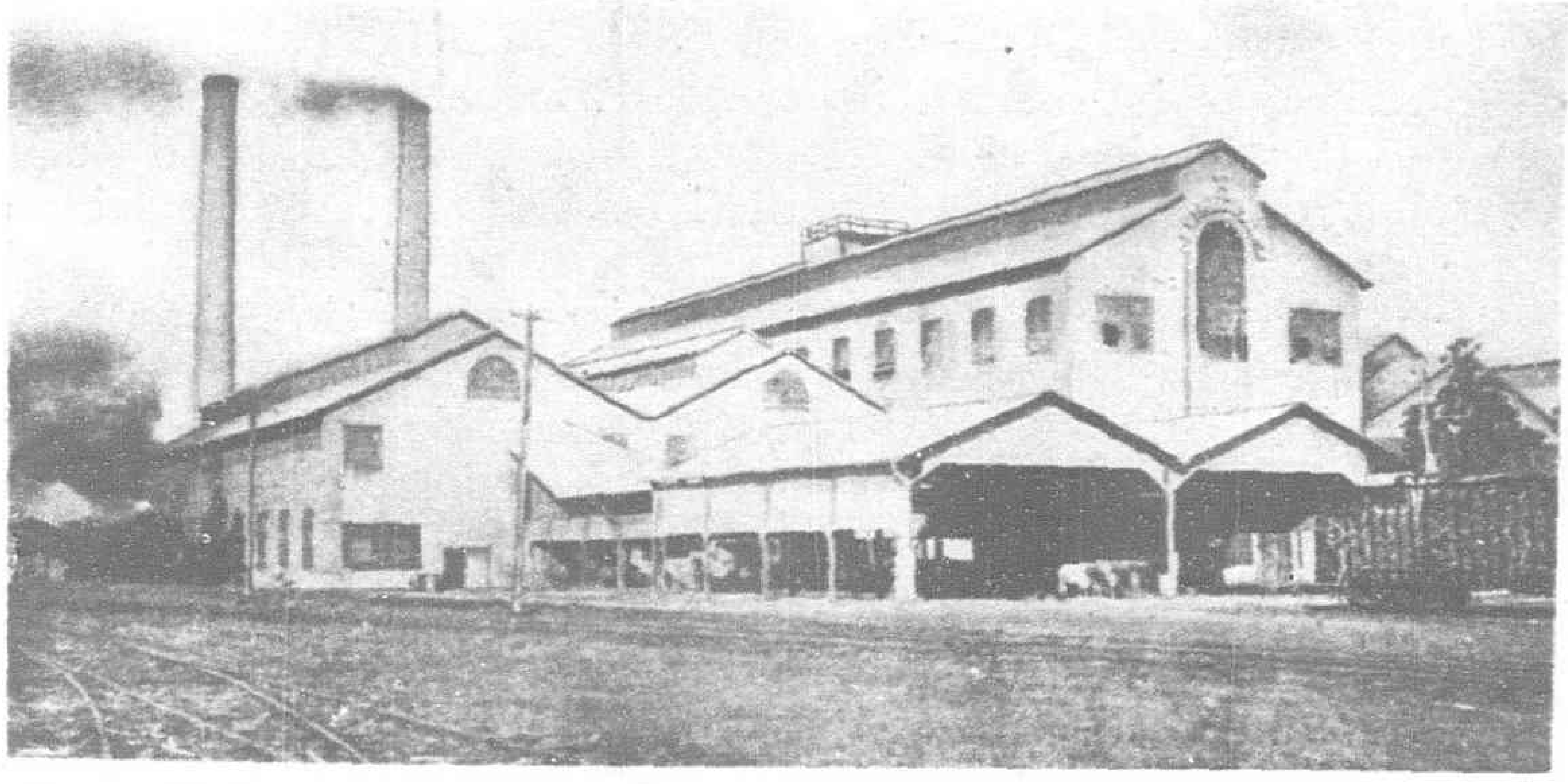
All-Steel Car after 12 Years' Service, Weakened by Corrosion so that it Buckled at the Center



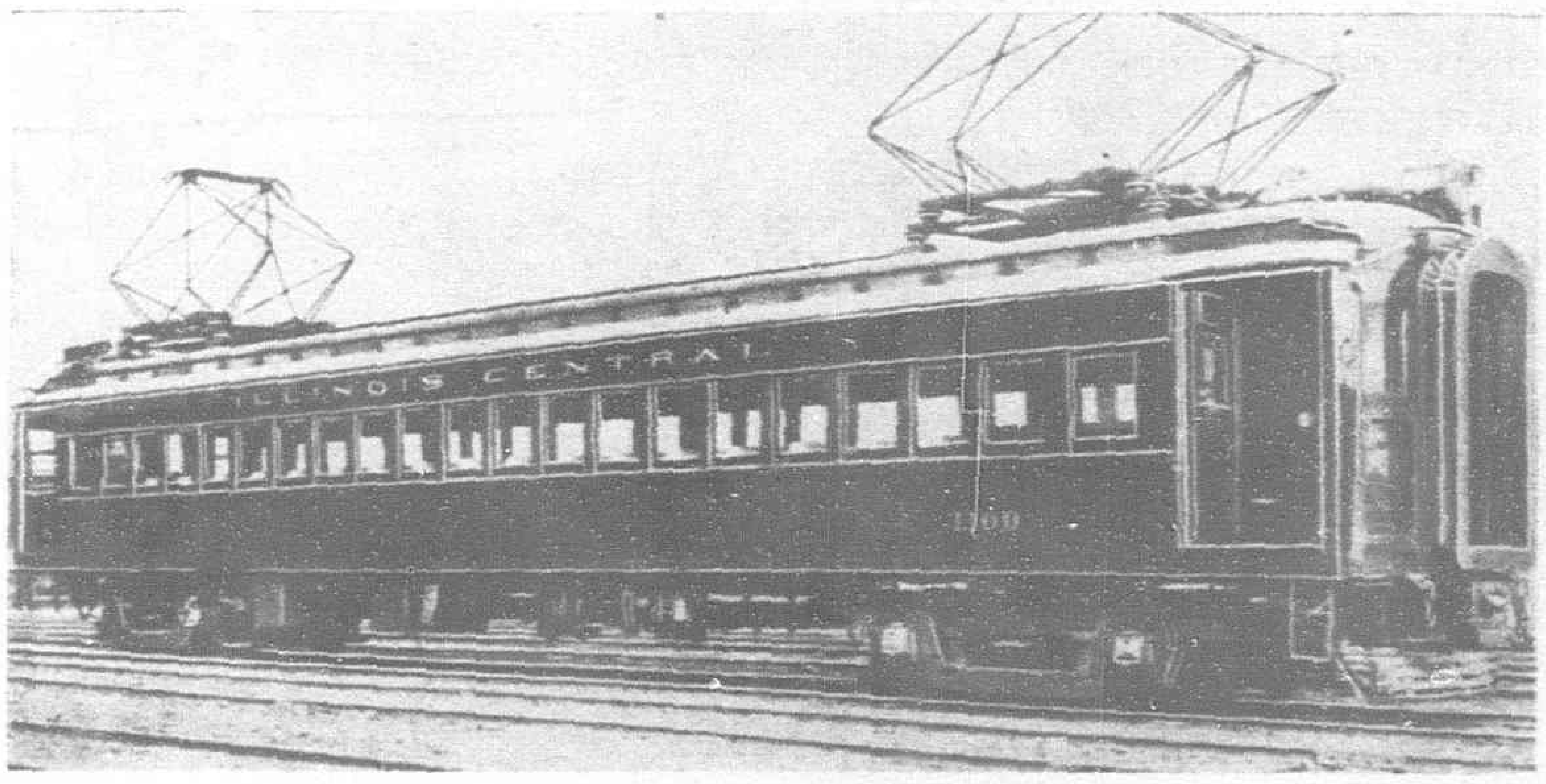
Hopper Car Rebuilt with Steel Containing Copper, which is Expecting to Give Much Longer Service than Ordinary Steel



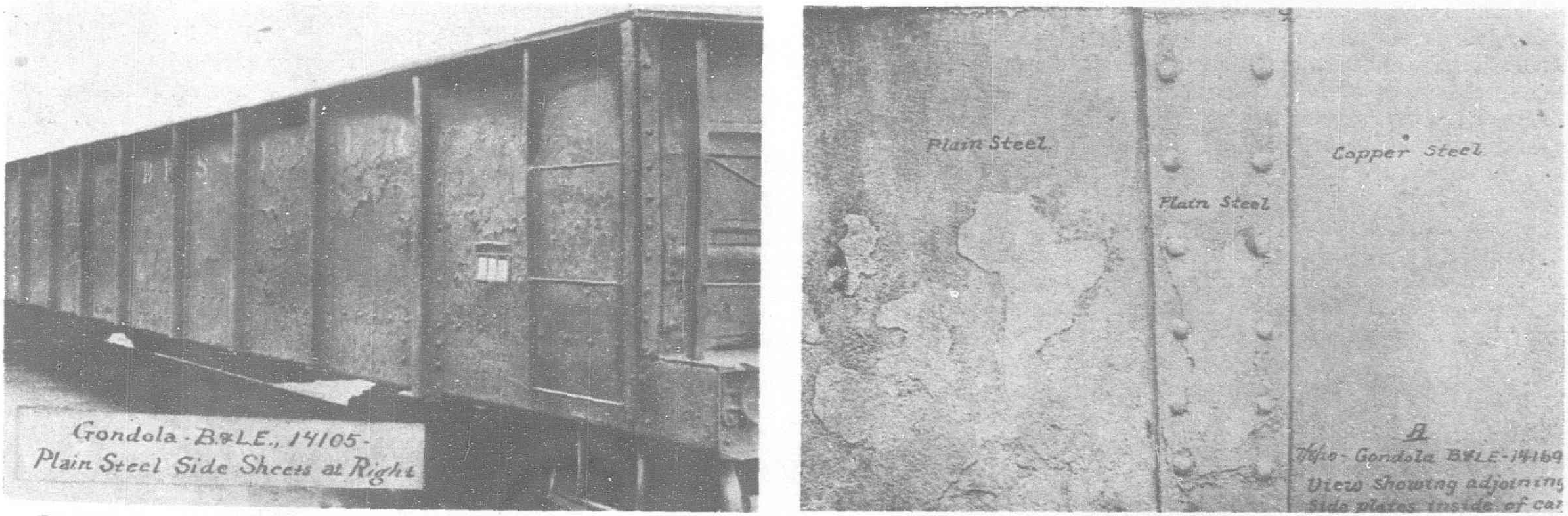
Steel Cars with Sides so Weakened by Corrosion that they will not hold Lading



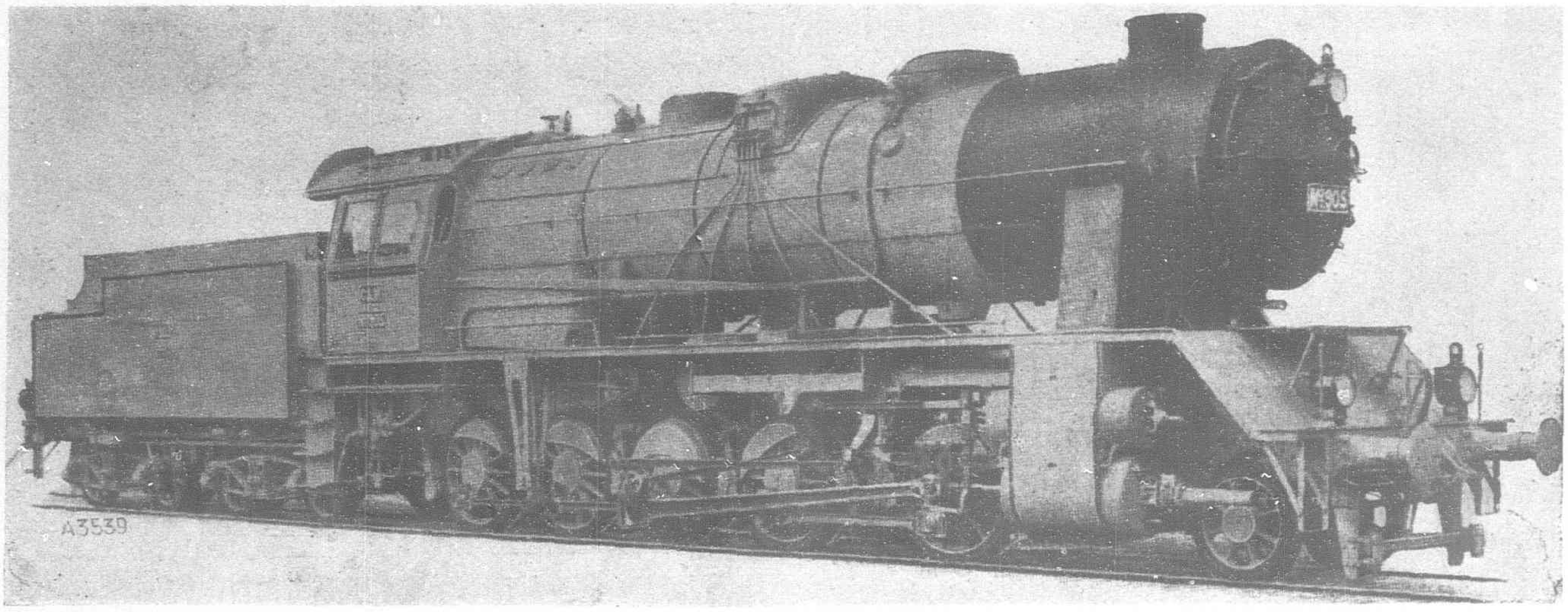
Sugar Mill in Cuba: Keystone Copper Steel Sheets used for Roofing



Typical Steel Car, Illinois Central Railroad: Keystone Copper Steel used in 260 of these Cars


Gondola - B&L.E., 14105-
Plain Steel Side Sheets at Right
Plain Steel
Copper Steel
Plain Steel
A
Photo- Gondola B&LE-14169
View Showing adjoining
Side plates inside of car

In 1914 the Bessemer & Lake Erie Railroad ordered 100 hopper and 100 gondola cars, using "both copper-steel and plain steel in each of the 200 car bodies. This was for the purpose of making a direct comparative test between the two kinds of material. At the end of six years, the plain steel showed an average loss of 18 per cent by corrosion, while the copper-steel showed an average loss of only 8 per cent, or less than half as much. Observe how the plain steel peeled. The rust formed in scales. As it peeled it took off the paint along with it, thus allowing new metal surfaces to be constantly exposed to the weather and encouraging still further corrosion



2-10-0 Borsig Superheated Steam Freight Locomotive for the Jugo-Slav State Railways

Recent Tendencies in Locomotive Construction

By Dr. ING. A. WEYERSBERG, Berlin, in "The Borsig Technical Review"

THE keen competition of motor vehicles has compelled the railroad administrations throughout the world to resort to methods of rationalization more than ever before. The problem facing them is, how to counteract the effects of such competition by the provision of more rapid and more comfortable transportation facilities without increasing expenditure.

The acquisition and upkeep of locomotives ranks among the principal items in connection with the companies' expenditure. It is but natural, therefore, that this item has been singled out for retrenchment purposes in preference to others, and that efforts are made to reduce the number of new orders by the better utilization of the existing engines and by spending less money on repairs than formerly. The time during which a locomotive must be withdrawn from operation owing to repair work can be very materially reduced if the accessories requiring repairs are made interchangeable. For this reason each railroad company maintains large stocks of such spare parts, thus finding itself confronted with the necessity of allowing considerable funds to lie dormant; and endeavors are now made to cut down as much as possible the number of parts kept in stock. This object can be achieved by making the parts needed for various types of locomotives as uniform as possible and by diminishing the number of such types, or—in other words—by far-reaching standardization and simplification. The automobile industry has gained important advantages from the introduction of mass production and has thus been able to cheapen the cars turned out by it; and the corresponding advantages can also be secured by the locomotive-building works. The interchangeability of the standardized parts is ensured by the system of tolerances on the "hole basis." The serial production of whole units, however, has no place in the scheme of locomotive construction, except in so far as certain small locomotives are concerned, because the working conditions are greatly different in the case of different types. It must suffice to refer, in this context, to differences with regard to gradients, curves, gauges, axle pressure, fuel, etc. Nevertheless, individual railroads have already in the past made attempts aiming at the maximum amount of uniformity in regard to their types of locomotives. A number of privately-owned railroads, more especially in the non-German and overseas countries, have succeeded in effecting a considerable simplification in the designs of individual parts and even of whole groups of parts, thus securing the advantage derived from small stocks, interchangeability of parts, simplified operation, and speedy repair work. The economic advantages resulting from a simplification of types, *i.e.*, the construction of locomotives designed on equal principles throughout, are so obvious that efforts have been made for a long time past aiming at the most far-reaching introduction of methods of standardization. Up to now, however, these endeavors have been restricted to the selection of a few special types and to the acquisition of large numbers of these. A connection between the various types has been practically non-existent, being regarded—indeed—as detrimental to the designing and to the further development of the locomotive industry. This view only underwent a change when the Deutsche Reichsbahn (German Railroad Corp.) introduced its standard locomotives, the salient feature of which is that standardization is not limited to single parts, but extends to whole constructional units, such as the boilers, cylinders, pairs of wheels and axle, etc., used in locomotives of different types and for different conditions of service.

The German Railroad Corporation owns a large number of such standardized locomotives, some of the principal types being illustrated on these pages. Other administrations have copied the example thus set. The increases effected in the speed and weight—especially that of the heavy express trains—necessitated more efficient locomotives, and these have been provided in Europe by the universal introduction of the 2 C 1=4—6—2, 2 D 1=4—8—2 and 1 D 1=2—8—2 types for express and ordinary passenger trains and that of the 1 D=2—8—0 and 1 E=2—10—0 types for goods trains.

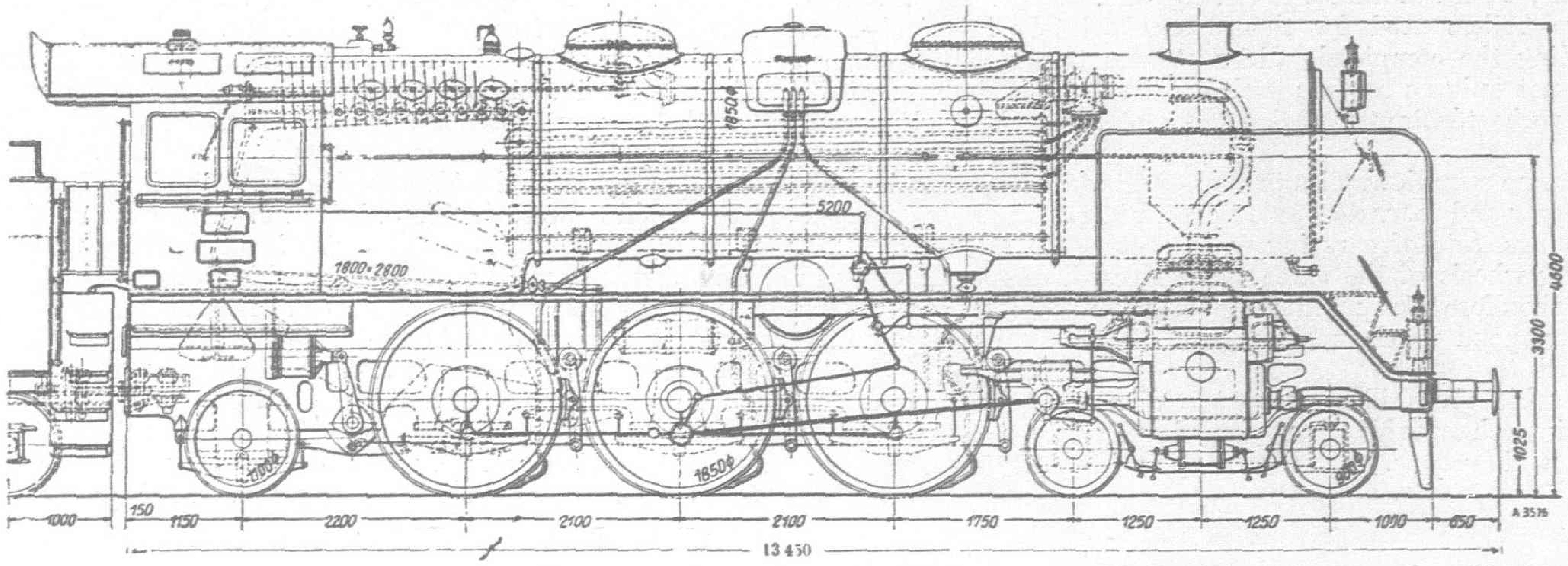
The weight of an express train varies, as a rule, from some 400 to 600 tons, and that of goods trains from 1,500 to 1,800 tons. If we take into account the respective speeds of these categories of trains, we find that the output figures of the locomotives required for the three chief kinds of trains—express, passenger and goods trains,—expressed in h.p., are very much the same. This circumstance—which, in itself, has been known for a long time past—has now been utilized in connection with the standardization problem. A large number of locomotives has just been supplied to the Yugo-Slav State Railroads; and the principle of standardization has been applied to this order to an extent not previously attained. The special traffic requirements of the country's railroad lines have been satisfied by the provision of the three types of locomotives described below.

(a) Express trains: Type 2 C 1=4—6—2, maximum speed: 62 miles, capable of hauling at its draw-hook—on lines whose average gradient is 1 in 100—a train weight of 400 to 500 tons, equal to from 10 to 12 corridor-train cars, at an average speed of from 31 to 37 miles per hour.

(b) Ordinary passenger trains and express: goods trains Type 1 D 1=2—8—2, maximum speed: 50 miles, capable of hauling (on gradients of 1 in 100) at its draw-hook a train weight of 600 tons at an average speed of from 35 to 31 miles.

(c) Goods trains: Type 1 E=2—10—0, maximum speed: 40 miles, capable of hauling (on gradients of 1 in 100) at its draw-hook a train weight of 900 tons average speed of from 25 to 31 miles.

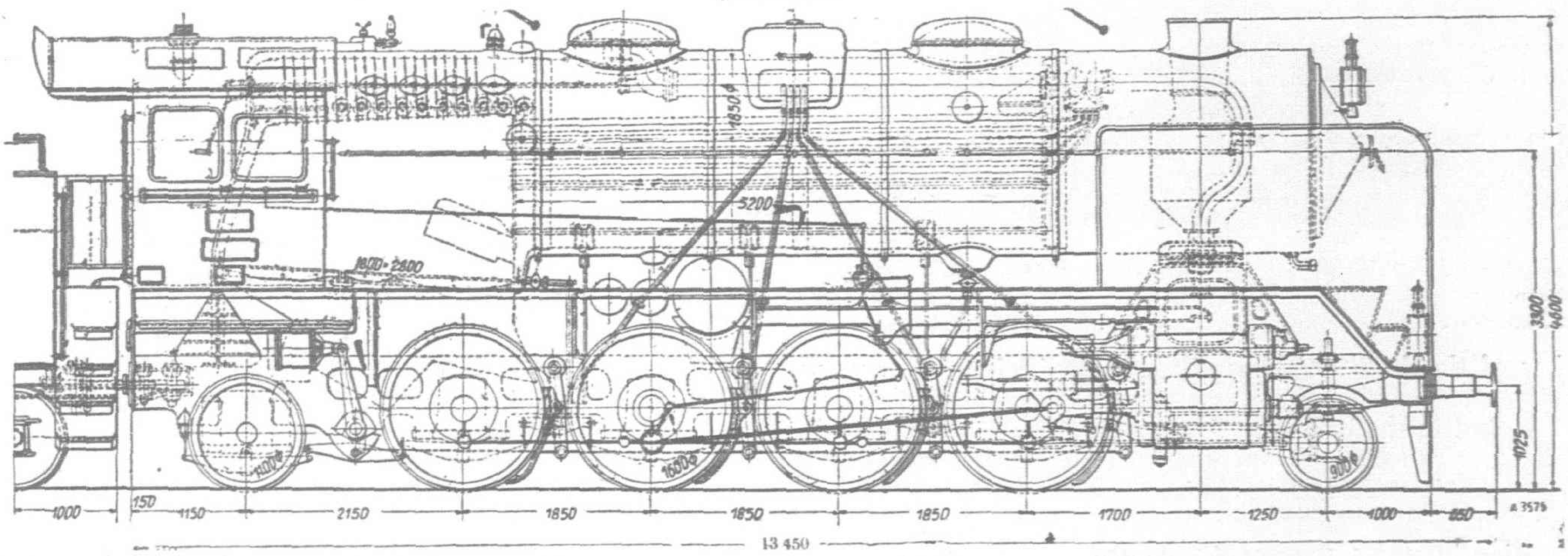
Standard Locomotives for the State Railway of Jugo-Slavia "Pacific"



Diameter of cylinders	22.13/16″	Steam pressure	228 lb.	Weight empty	89.6 tons
Piston stroke	26″	Evaporative heating surface	2,400 sq. ft.	Weight in working order	98.5 tons
Driving wheel diameter	6′ 13/16″	Superheater surface	785 .	Weight on drivers	53.2 tons
Rigid wheel base of locomotive	13′ 9⅜″	Total heating surface	3,185 ,,	Tractive force (0.85 p)	36,000 lb.
Total wheel base of locomotive	34′ 11.5/16″	Grate area	53.5 ,,	Tank capacity	5,500 i.g.
Total wheel base of locomotive and tender	61′ 4¼″	156 small flue tubes	1.5/16′/2⅛″	Coal capacity	10 tons
		34 large flue tubes	5.5/16′/5⅝″	Tender Weight empty	24.5 tons
		34 superheater tubes	1.3/16″/1½″	Tender Weight loaded	59 tons

Length of locomotive over buffers, 44′ 1½″. Total length of locomotive and tender over buffers, 71′ 10¼″. Gauge, 4′ 8½″

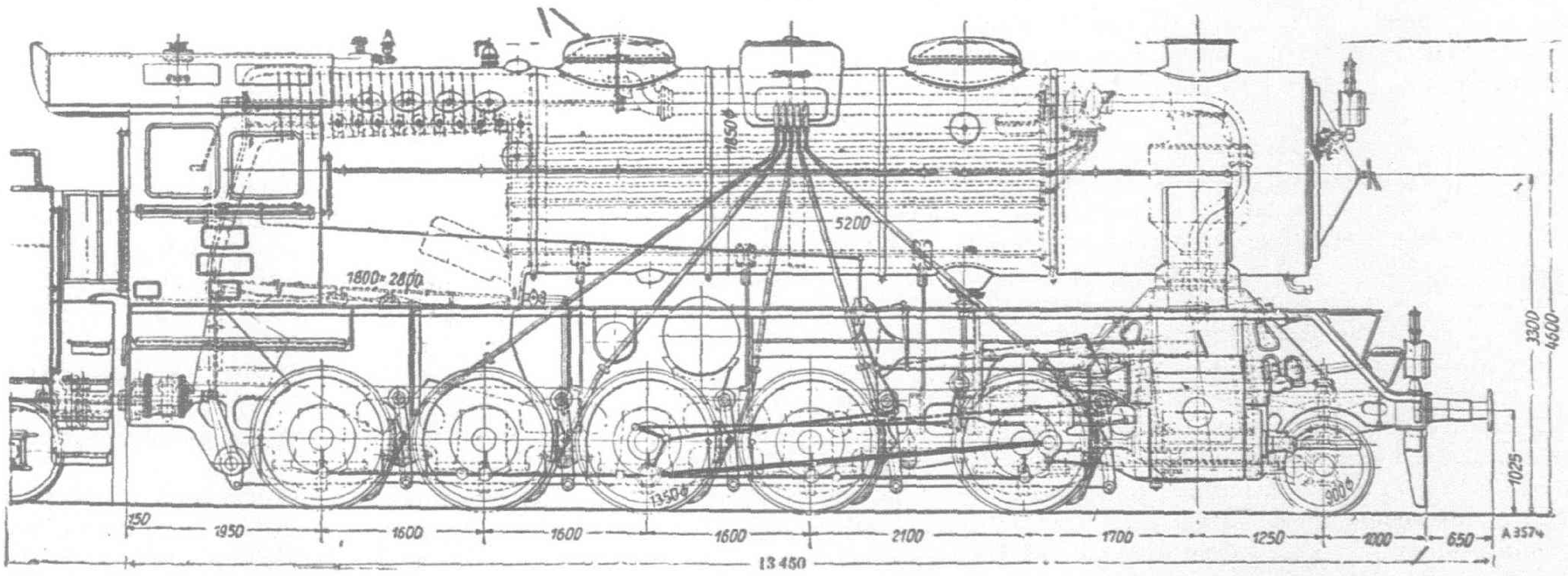
"Micado"



Diameter of cylinders	24.13/16″	Steam pressure	228 lb.	Weight empty	92.6 tons
Piston Stroke	26″	Evaporative heating surface	2,400 sq. ft.	Weight in working order	100.5 tons
Driving wheel diameter	5′ 3″	Superheater surface	785 ,,	Weight on drivers	71 tons
Rigid wheel base of locomotive	12″ 1.11/16″	Total heating surface	3,185 ,,	Tractive force (0.85 p)	49,000 lb.
Total wheel base of locomotive	34′ 11.5/16″	Grate area	53.5 ,,	Tank capacity	5,500 i. g.
Total wheel base of locomotive and tender	61′ 4¼″	156 small flue tubes	1.5/16″/2⅛″	Coal space	10 tons
		34 superheater tubes	1.3/16/1½″	Tender Weight empty	24.5 tons
				Tender Weight loaded	59 tons

Length of locomotive over buffers, 44′ 1½″. Total length of locomotive and tender over buffers, 71′ 10¼″. Gauge, 4′ 8½″.

"Decapod"



Diameter of cylinders	3 × 21⅝″	Steam pressure	228 lb.	Weight empty	95.8 tons
Piston stroke	26″	Evaporative heating surface	2,400 sq. ft.	Weight in working order	103.5 tons
Driving wheel diameter	4′ 5.3/16″	Superheater surface	785 ,,	Weight on drivers	88.7 tons
Rigid wheel base of locomotive	10′ 6″	Total heating surface	3,185 ,,	Tractive force (9.85 p)	6,680 lb.
Total wheel base of locomotive	32′ 3.3/16″	Grata area	53.5 ,,	Tank capacity	5,500 i. g.
Total wheel base of locomotive and tender	61′ 4¼″	156 small flus tubes	1.5/16″/2⅛″	Coal capacity	10 tons
		34 large flue tubes	5.5/16″/5⅝″	Tender Weight empty	24.5 tons
		34 superheater tubes	1.3/16/1½″	Tender Weight loaded	59 tons

Length of locomotive over buffers, 44′ 1½″. Total length of locomotive and tender over buffers, 71′ 10¼″. Gauge, 4′ 8½″.

The constructional elements of these three types are, as nearly as possible, identical and interchangeable. Thus, for instance, the entire boilers used for them are absolutely identical—notwithstanding the completely different uses to which the engines are put—not only as regards such details as their fireboxes, tube sheets, superheater fire tubes, flue tubes, etc., but also their general designs.

The same remark applies to those parts which are particularly liable to wear and tear, *e.g.*, axle boxes, rod bearing brasses, brake shoes, springs, sets of carrying wheels, etc. On the other hand, the driving wheels of the three types have diameters differing in size and therefore also maximum boiler output for those speeds which correspond to the purpose which each type of locomotive is intended to serve.

The table given illustrates at a glance the uniform design and the interchangeable character of the various constructional elements and groups.

Type	4-6-2	2-8-2	2-10-0
gauge	—	$4'8\frac{1}{2}''$	—
diameter of cylinders	$22\frac{13}{16}''$	$24\frac{13}{16}''$	$3\times21\frac{5}{8}''$
piston stroke	—	26″	—
driving wheel diameter	$6'$-$\frac{13}{16}''$	5′-3″	$4'$-$5\frac{3}{16}''$
diameter of leading bogie wheels	—	$2'$-$11\frac{3}{8}''$	—
diameter of trailing bogie wheels	$3'$-$7\frac{3}{8}''$	$3'$-$7\frac{3}{8}''$	—
rigid wheel base	$13'$-$9\frac{3}{8}''$	$12'$-$1\frac{11}{16}''$	10′-6″
total wheel base	$34'$-$11\frac{5}{16}''$	$34'$-$11\frac{5}{16}''$	$32'$-$3\frac{3}{16}''$
total wheel base of locomotive and tender	—	$61'$-$4\frac{1}{4}''$	—
Type	4-6-2	2-8-2	2-10-0
steam pressure	—	228 lb/sq. in.	—
grate area	—	53,5 sq. ft.	—
evaporative heating surface	—	2,400 sq. ft.	—
superheater surface	—	785 sq. ft.	--
total heating surface	—	3,185 sq. ft.	—
weight empty	89,6 tons	92,6 tons	95,8 tons
weight in working order	98,5 tons	100,5 tons	103,5 tons
weight on drivers	53,2 tons	71 tons	88,7 tons
tractive force	36,000 lb.	49,000 lb.	66,800 lb.
	tender		
tank capacity	—	5,500 i.g.	—
coal capacity	—	10 tons	—
weight empty	—	24,1 tons	—
weight loaded	—	58,1 tons	—

In view of the fact that these types may be looked upon as representatives of that aspect of modern locomotive construction which is devoted to the building of units capable of being used in actual every-day practice, as opposed to engines built for experimental purposes, it may not be amiss to give short descriptions of them and to discuss the modern problems in general.

The boiler operates under a pressure (above atmospheric) of 228 lb. per sq. in. This figure may be considered, for the present at least, as the normal maximum for staybolt boilers in conjunction with single expansion and Heusinger-Walschaert's link motion. It is quite true that it will be possible to increase the pressure for boilers of standard design to 284 and more lb. per sq. in. (and this has actually been done in connection with some experimental engines recently turned out); but this step necessitates either the choice of boiler sheets consisting of high-grade and therefore expensive material, or else an increase in weight, which renders it difficult to maintain axle pressure. Besides, the higher pressure has up to now been resorted to in those instances only in which single-stage expansion has been replaced by the more complicated compound or two-stage expansion. It is frequently asserted nowadays that the simplest method of improving the remunerativeness of locomotive building is, to resort to pressures (above atmospheric) exceeding even 284 lb. per sq. in.; but this view is erroneous. The high-pressure locomotives turned out so far have indeed been able to produce more or less exactly the decrease in steam consumption (on their trial runs) theoretically calculated to ensure; it is, however, still exceedingly doubtful whether these expensive engines —more especially their boiler constructions—are more remunerative than others, if the general aspect of the problem is considered, instead of its merely thermo-dynamical aspect.

The boiler barrel, whose center line is located 129.8 in. above the upper edge of the rails, consists of two cylindrical shell rings, whose maximum internal diameter is 72.8 in. The firebox has a slanting rear plate, whilst the front plate extends downward after the manner of a trough, thus increasing the available furnace depth along the tube sheets.

As the heating value of the kind of coal used as fuel ranges between 7,200 and 9,000 B. T. U. per lb., the grate has been amply proportioned, the ratio between its area and the heating surface being 1 : 47. Its central portion can be tilted by means of a spindle. The heating surface comprises 154.3 sq. ft. in the copper firebox, 156 heating tubes of 2.12/1.93 in. diameter and 34 smoke tubes of 5.64/5.32 in. diameter, which account for 2,210 sq. ft., if the length between the tube sheets is set down at 204.5 in. To this heating surface of 2,360 sq. ft. should be added another 742 sq. ft. in respect of the Schmidt superheater. The ratio between the two last-named figures, therefore, is 3.2 : 1. The characteristic features relating to the tubes are likewise in conformity with the results of modern research, according to which the ratio of tube section to tube friction surface (the latter to include the superheater coils) should be approximately the same for heating and smoke tubes. The ratio for the former is 1: 425 and that for the latter 1 : 445.

The adjustment of boiler and driving gear proportions, which is characterized by the ratio existing between the cylinder volume and the heating surface, was effected with particular care for the types of locomotives here concerned. Their respective figures are :—0.75 ;—0.88, and—1.01.

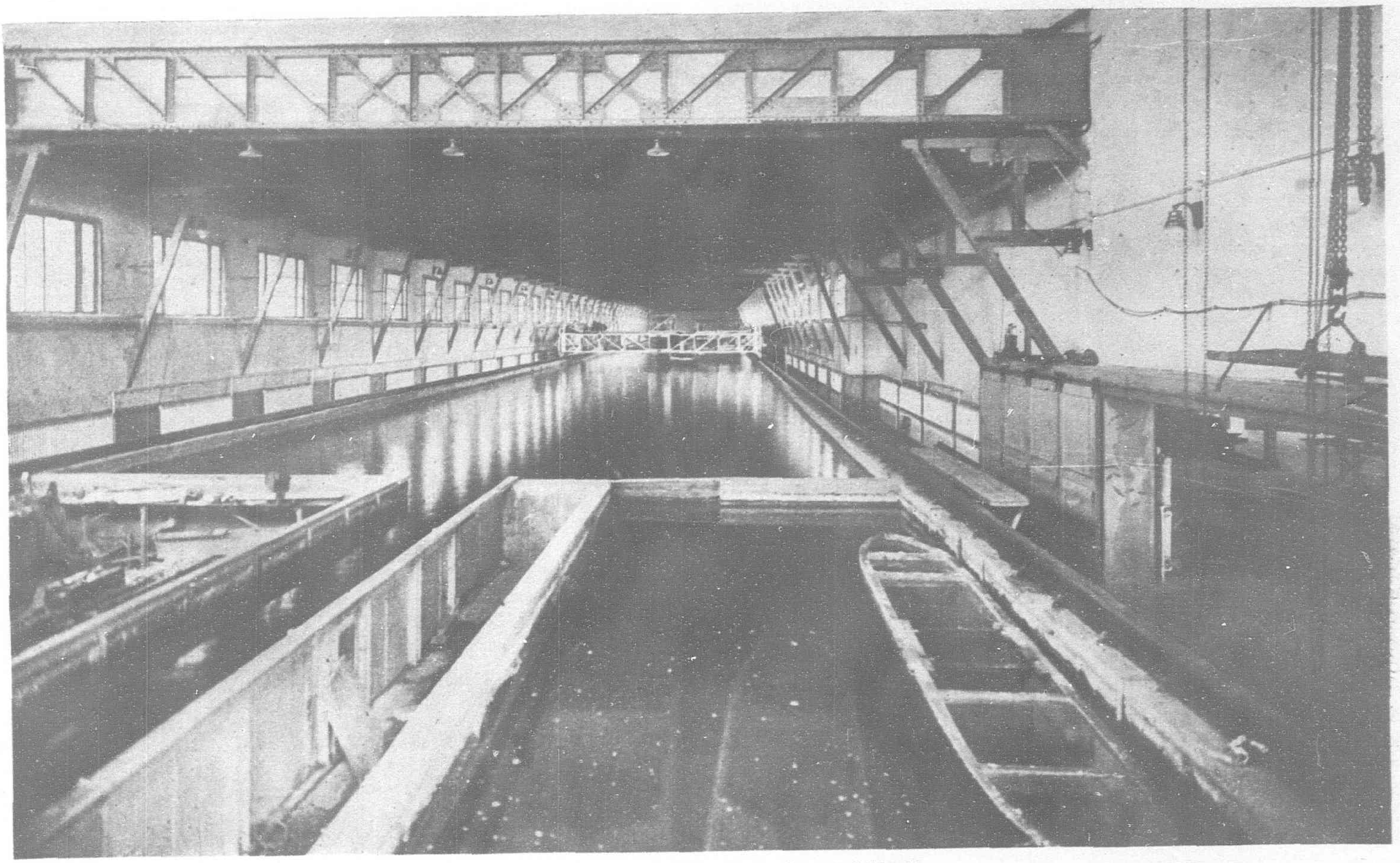
The boiler is fed by two Friedmann injectors, the one on the lefthand side being an exhaust injector. The feed valves are of the type used by the German Railroad Corporation. The efficiency of the exhaust injector is almost identical with that of the much heavier and much more expensive surface pre-heater. Additional advantages are its easier attendance and upkeep. Other parts of the boiler outfit include two Popp safety valves (inside diameter 3.74 in. each), two automatically closing water gauges and one Marcotty door. The latter differs from the ordinary kind of door by the greater height of the firehole, thus giving better access to the large grate. A Siemens-Halske tele-pyrometer indicates the temperature of the superheated steam in the slide-valve chest. The domes are made of cast steel, angle rings being dispensed with altogether. The front dome is fitted with a water purifier (G. R. Corp. system) and the rear dome with a double-seat drop-valve regulator. The front portion of the boiler is supported by a cast-steel smoke-box support, the upper part of which is detachable, a centring device being provided to facilitate the putting-in and the taking-out of the boiler and the interchange of boilers belonging to different classes of locomotives.

The frame of all three types is formed of 100-mm bars, finished on all sides and being of equal length throughout. The transverse stiffening of the frame is effected by the robust plate buffer support, by forged struts at the openings for the axle boxes, by the cast-steel fire box support and by the coupling box. Formerly plate frames were very largely used, especially in the European countries, but preference is nowdays given to bar frames because of their greater simplicity in design, their greater accessibility, the simpler methods of fixing the axle-bearing guides, the easier arrangements for fastening the cylinders, and the reduced number of rivets, screws and transverse stiffenings required. Modern bar frames as now used in Europe are cut from homogeneously rolled steel sheets. They, therefore, are exempt from the defects inhering to American frames made of cast steel owing to the want of uniformity in the material used.

The high position of the boiler has made it possible to reduce the length of the total wheel bases. The bogie (truck) of the type of locomotive, however, has been provided with a wheel base larger than the customary one, in order to enable the use of long and flexible bearing springs, apart from accommodating the brake in a suitable manner. Another notable feature of the bogie (truck) is the continuous pressure disc with sliding faces subject to lubrication and the relieving or balancing device for fitting the brake cylinder to the frame. The driving axle boxes consist of three parts (Obergethmann type), the original type having been improved upon by a particularly suitable method of effecting the lateral support of the lower parts of the bearings and the lower box. Finally, an important innovation is the securing of the axle-box adjusting wedges by a special type of bush.

The driving gear of the type of locomotive engages with the middle axle and that of the type with the third coupled axle, whilst in the case of the I E type the outside cylinder acts upon the third and the inside cylinder upon the second coupled axle. Piston rods as well as slide rods are provided with front guides according to the simplified G. R. Corp. type, the slide-rod guides being designed in such a manner that the front and rear stuffing boxes could be designed identically.

(*Continued on page 329.*)



General View of Ship Experimental Tank

Ship Experimental Tank of Imperial Japanese Government

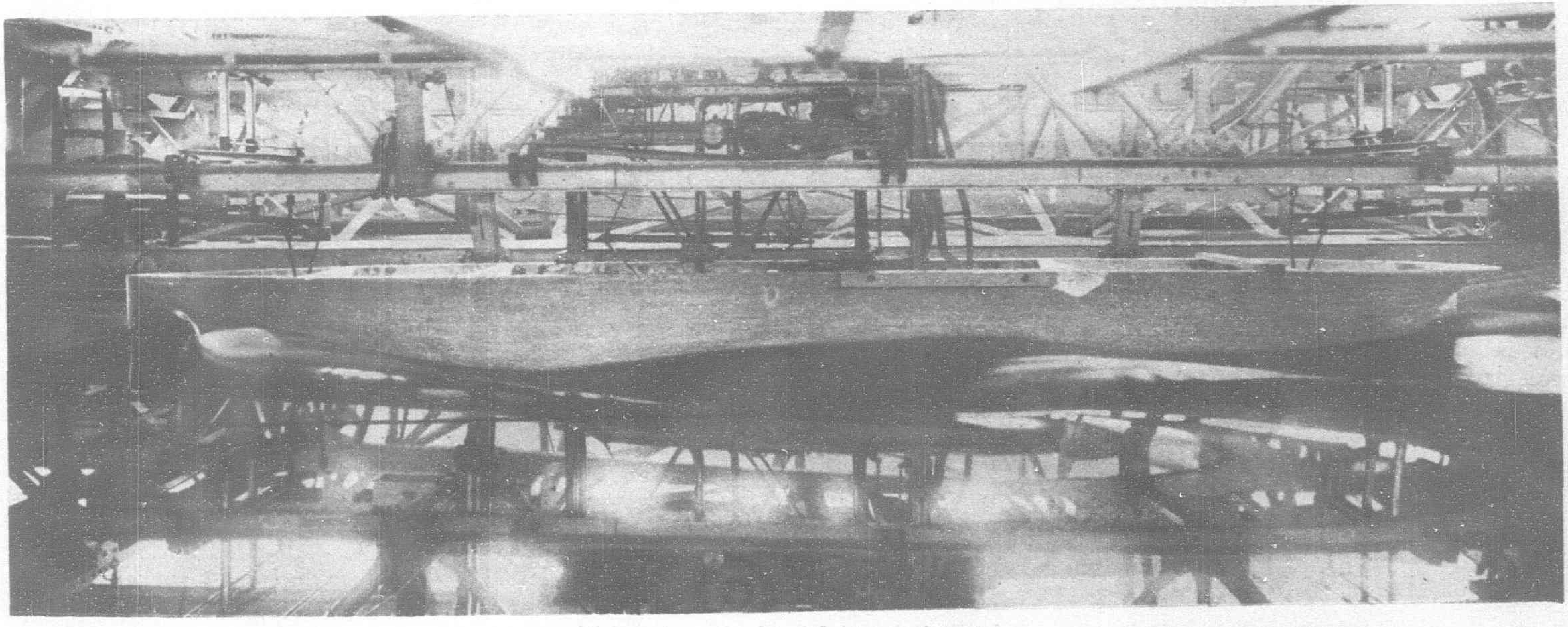
By *S. ARAKI*

The tank, built of reinforced concrete, is 139.15 m. long, 10.00 m. wide and 6.30 m. deep. Its construction was finished in December, 1925, and its flooding in January, 1927.

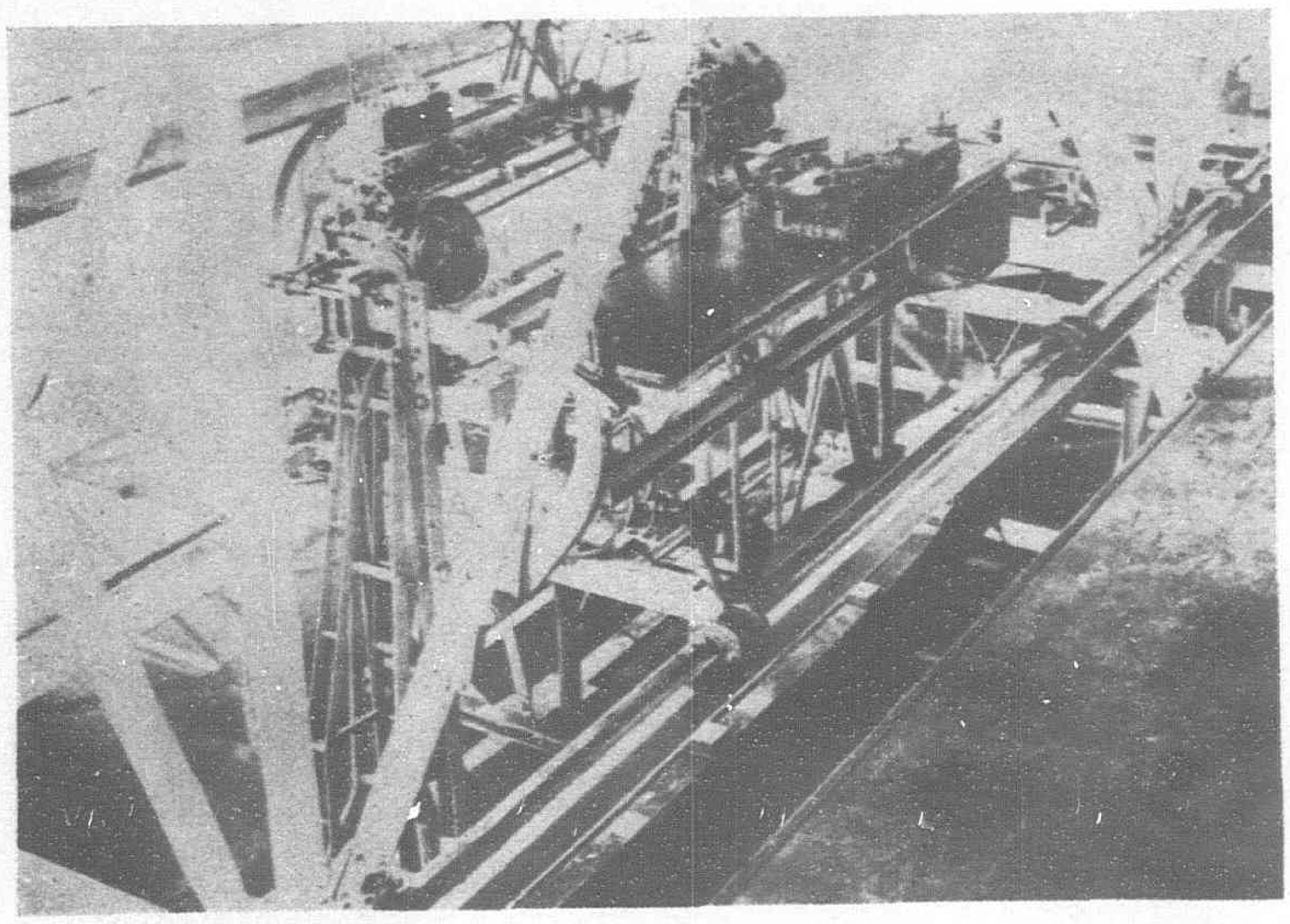
The rails for the electric carriage are of 90 lb, with 10.4 m. gauge. The carriage, built entirely of steel, is about 11 tons in weight, driven by four motors of 110 volts and 8.8 kilowatts each and can have any speed between 0.35 m. to 8.00 m. per second. There are installed 25 storage batteries with a total capacity of about 725 ampere hours/10 hours.

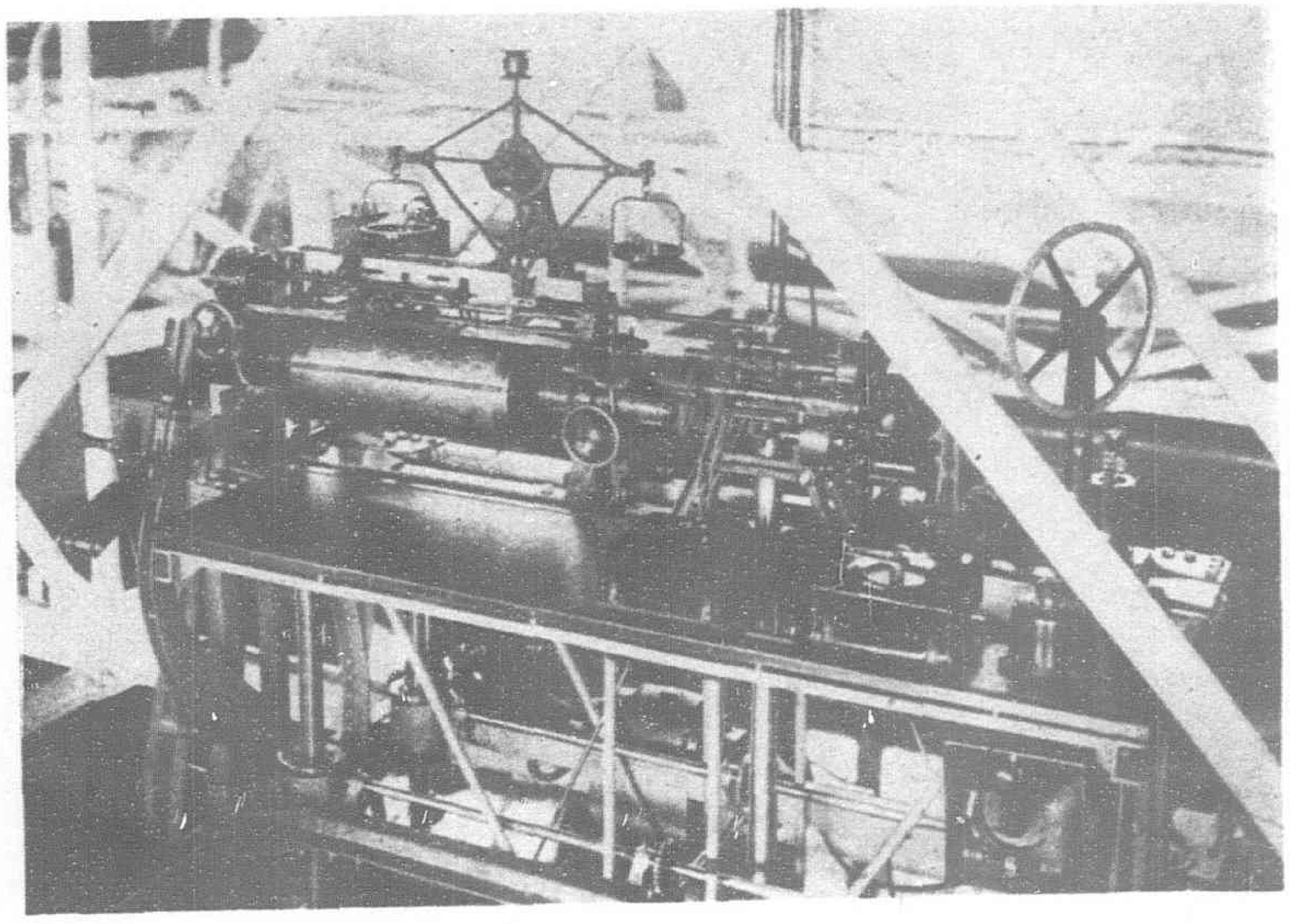
The measuring apparatus, such as resistance dynamometer, propeller dynamometers etc., are of the most up-to-date types similar to those adopted by the leading experimental tanks in the world.

The model shaping machine is of Vulkan type ; the maximum size of models is to be 7.5 m. in length and 1.15 m. in width.



Model Ship under Towing Experiment



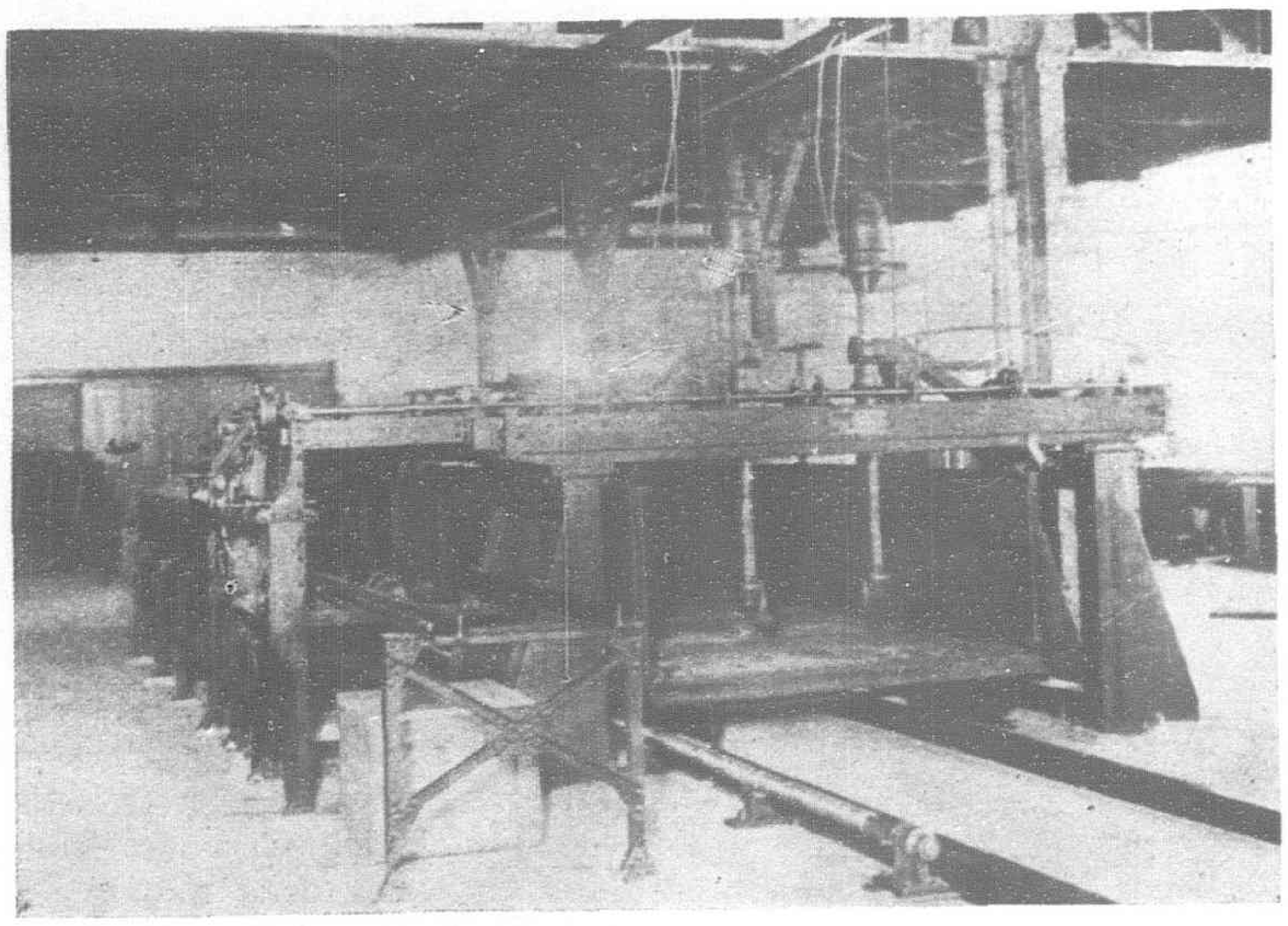


Ship Experimental Tank: Resistance and Power Meter

The paraffin melter has a capacity of 700 kilograms. Two moulding boxes, 8.00 m. long, 1.44 m. and 1.24 m. wide and 0.85 m. deep, are prepared for casting ship models.

This remarkable installation was designed mostly by Dr. Friedrich Gebers, the superintendent of the Vienna Experimental Tank, combining various superior points of existing tanks in the world. About 775,000.00 gold yen and more than five years were spent in the construction and fitting out of the tank.

By making model experiments in the tank, the resistance of a vessel and the efficiency of a propeller can be determined, and thence, the most suitable form, proportions etc. of a vessel of any kind, war-ship, passenger liner, cargo boat, shallow drafter, tanker, barge, etc. and the most suitable pitch, diameter, area etc. of a propeller for a particular vessel can be found out in short time with comparatively cheap fees.



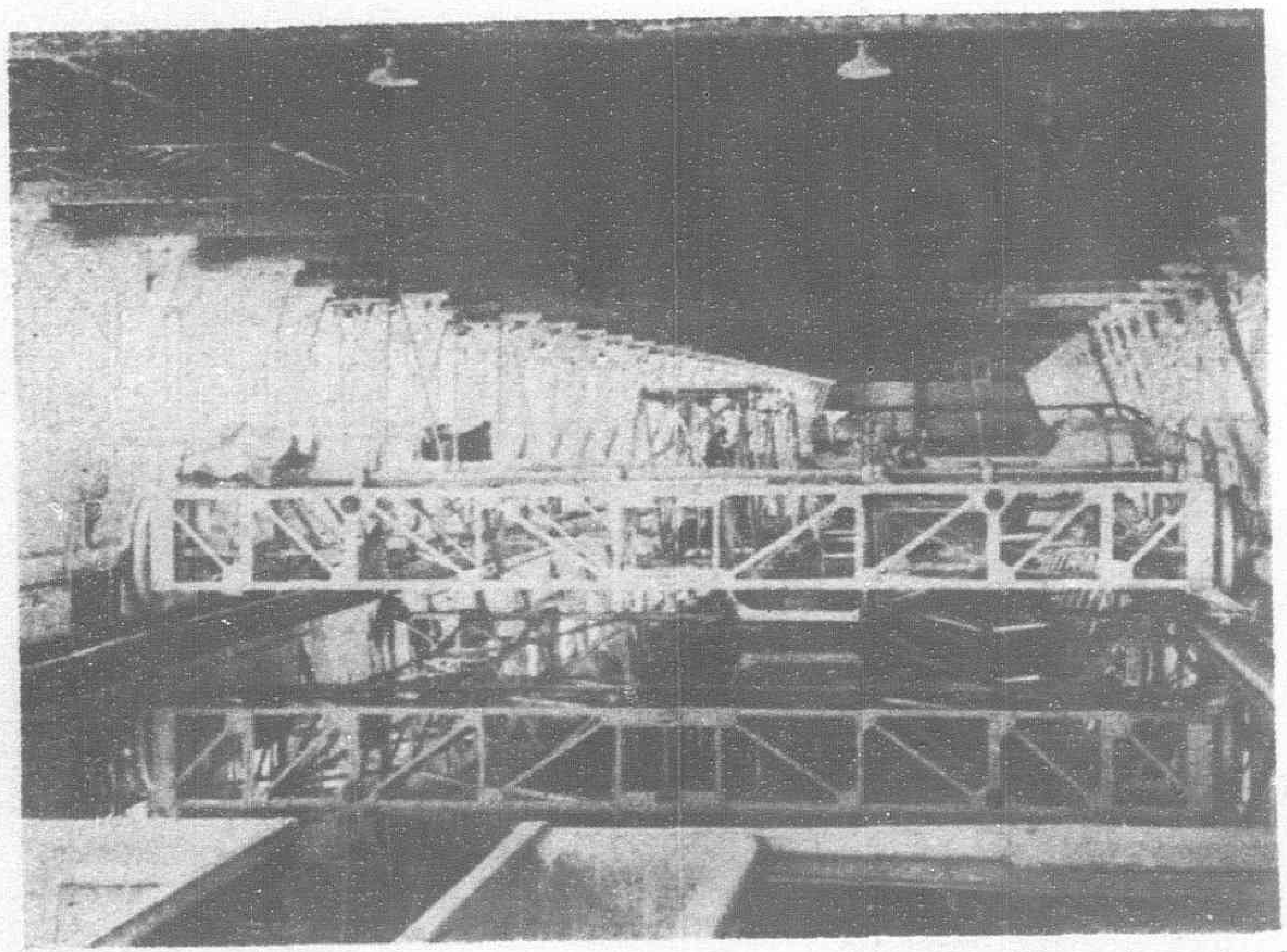
Ship Experimental Tank; Model Making Machine

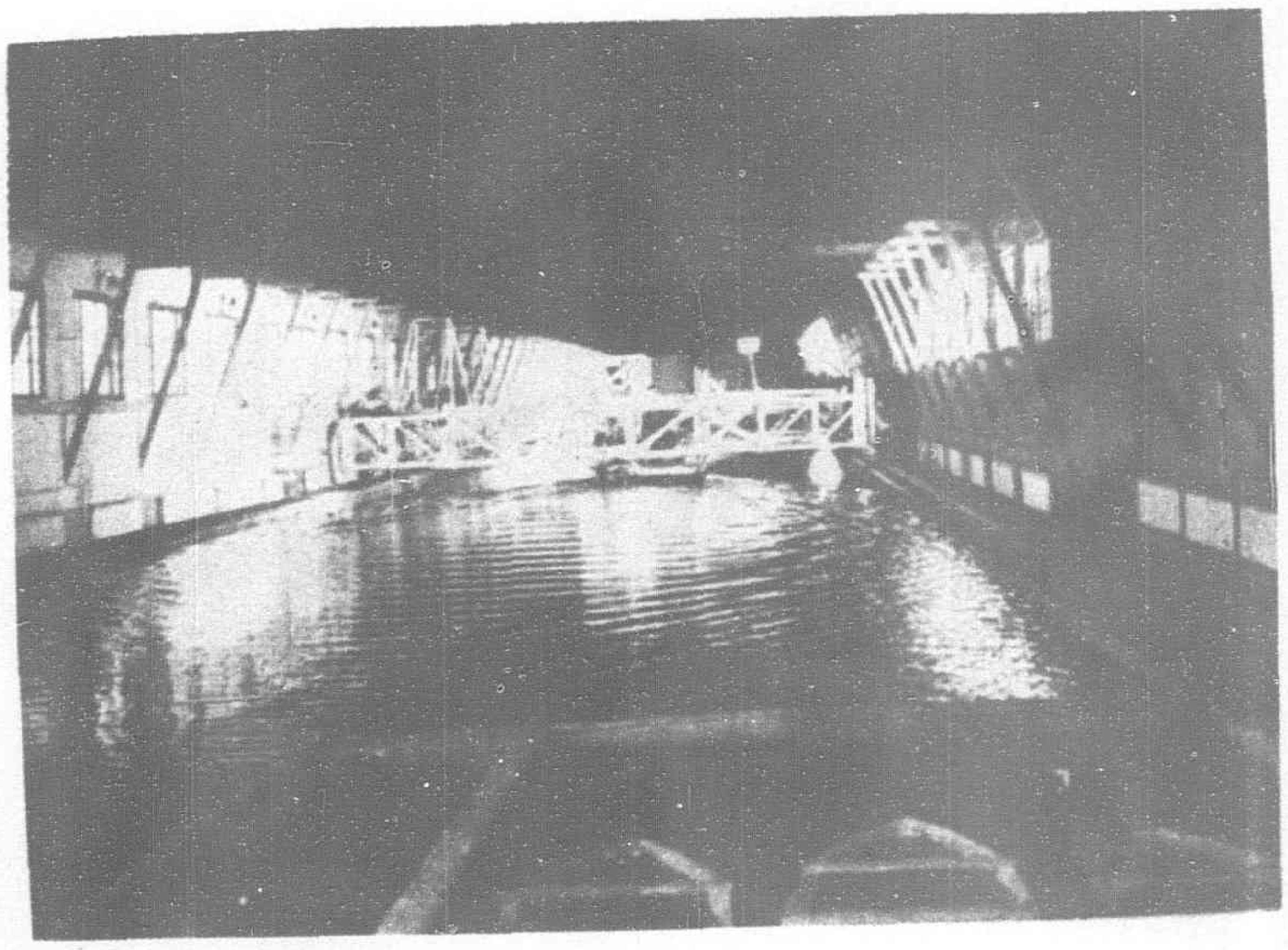
Starting work in 1927, the tank institution up to 1930, has determined the resistance of hull models for 16 ships, the suitable forms of hulls for six ships, the efficiency of a propeller model for a ship and the suitable form of propeller for a ship, and made five sets of special experiments, all to the demands from shipbuilders, shipowners and others.

It is not an exaggeration to speak of the importance of tank experiments in connection with the economy of the propelling power of ships, especially under the present depressed condition of shipping. It is becoming a usual practice to stipulate in the specification of a ship to be built that the ship's form must be based upon satisfactory tank experiments, while similar attention is being paid for propellers.

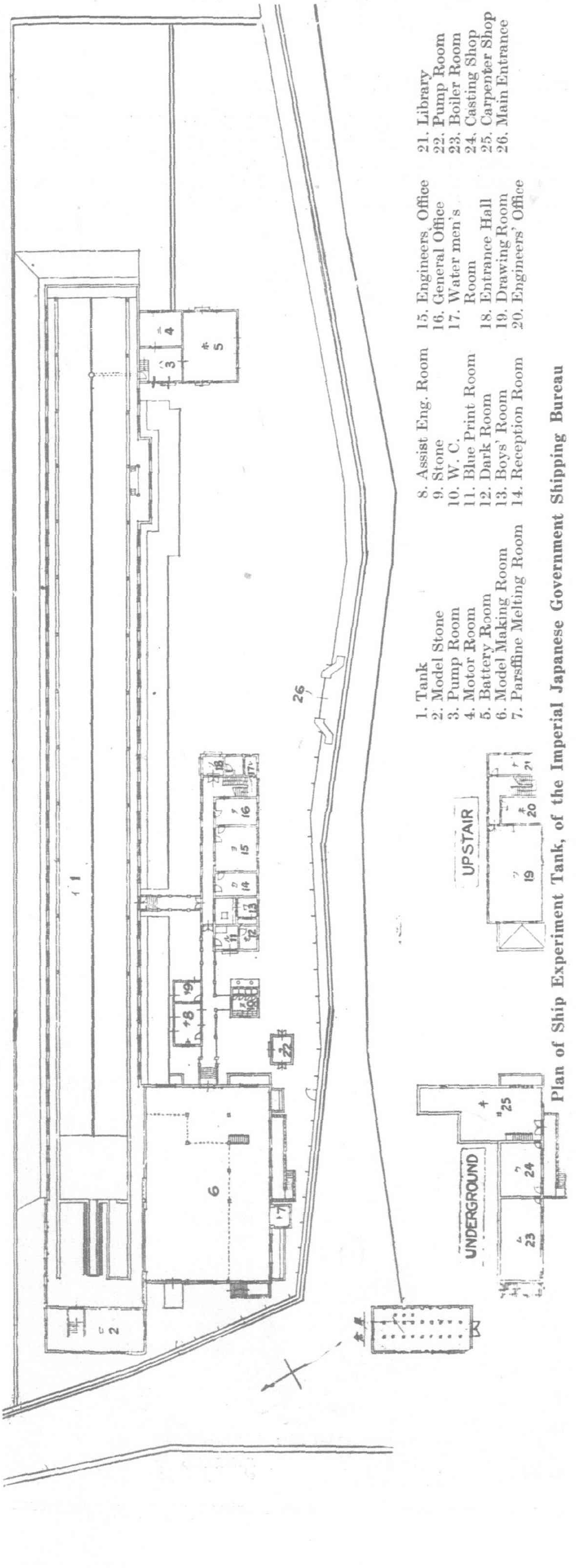
The service of the tank institution is open to the demands not only from Japan but also from other countries, and will contribute very much to the development of the design and construction of various types of ships in the Far East where less endeavors have been made in this most difficult technical line than in European shipbuilding countries.

Particulars can be had through Messrs. Doi, Araki and Watanabe, 24 The Bund, Shanghai.





Ship Experimental Tank; Towing Platform



1. Tank
2. Model Stone
3. Pump Room
4. Motor Room
5. Battery Room
6. Model Making Room
7. Parsffine Melting Room
8. Assist Eng. Room
9. Stone
10. W. C.
11. Blue Print Room
12. Dark Room
13. Boys' Room
14. Reception Room
15. Engineers' Office
16. General Office
17. Water men's Room
18. Entrance Hall
19. Drawing Room
20. Engineers' Office
21. Library
22. Pump Room
23. Boiler Room
24. Casting Shop
25. Carpenter Shop
26. Main Entrance

Plan of Ship Experiment Tank, of the Imperial Japanese Government Shipping Bureau

Recent Tendencies in Locomotive Construction

(*Continued from page 326*).

The cylinders are screwed on to the frame by reamed bolts. They are fitted with a by-pass valve, which—by means of flaps—releases large sections, thus reducing the no-load compensating work almost to nil. The crossheads are provided with one slipper only. The driving rods are fitted with adjustable bearings at both ends, those of the inside driving rods being designed as an open fork with a powerful yoke added to it. The coupling rods have closed bush bearings lined with anti-friction metal, a type which is becoming more and more generally used nowadays. The vessels required for the lubrication of the driving and coupling pins and for that of the gearing mechanism have been cut from the solid. They are made oilproof by caps welded on to them and are fitted with spring covers. The oil is conveyed to the points of lubrication by a nipple fitted with calibrated needles.

The cylinders, slide valves and axle boxes are lubricated by two Friedmann pumps accommodated near the driver's cab, the total number of connections varying between 12 and 21 according to the number of axles.

The link motion is of the Heusinger-Walschaert type, and is notable for the skilful designing of the individual parts, such as the controlling rod with single head and medium fish-bellied guide and the elegant construction of the open link. The valve gear of the inside cylinder of the type of locomotive is actuated by a detachable double return crank fitted to the righthand driving pin. All the bushes of the inside parts of valve motion, as well as the slide blocks, are made of phosphor bronze.

The driver's cab is of ample proportions. It is fitted with wind screens and large side windows (the one at the rear being a sliding window), thus giving the driver a good view of the line. The roof is provided with ventilation flaps of large size. The fittings in the driver's cab are arranged in a practical manner. The levers are easily accessible. The hand wheels of the steam connection are all in one single row and on the right level. The regulator handle may be retained in any desired position by means of a spring-actuated thumb nut. The reversing gear operated by hand wheel and notch plate is located on the righthand side, where the reversing-gear control bracket is screwed on to the boiler.

The locomotives here described are fitted with a compressed-air brake, including a Nielebock-Knorr double compound air brake valve. This type of valve is largely used on the Yugo-Slav State Railroads. In addition, there is a hand spindle brake on the tender. The well-known Borsig compressed air sand-spraying device supplies all coupled axles with sand from the sand box on top of the boiler between the two domes. The equipment further consists of a tyre spray for the carrying axle, a Hassler velocity gauge, a gas-lighting plant and a steam-heating plant. The tender is of the standard four-axle type with diamond bogie (truck). The water inlet lies 107,6-in. above the top edge of the rails and is of elongated shape, thus considerably facilitating the water supply.

The trial runs of the locomotives have shown—both as regards the types used for express trains and for goods trains—that the principles of their construction are sound. As far as our knowledge goes, this is the first demonstration of the practical usefulness of locomotives of uniform type for three different categories of purposes.

New Bridges for the Philippines

THE vast program of bridge construction to be undertaken by the bureau of public works in all parts of the Islands this year arranged in order of intensity of vehicular traffic was released by A. D. Williams, director of public works, recently.

The entire project consisting of 34 bridges located in 32 different provinces will be financed out of the revolving fund amounting to P.5,000,000.

The projects are distributed as follows: three bridges in Iloilo, the Jalaud river bridge, the Tigbauan river bridge, and the Guimbal river bridge; four in Isabela, the Calao or Santiago river bridge, the Pinacanauan river bridge, the Ganao river bridge, and the Ipil river bridge; three in Occidental Negros,

(*Continued on page 331*).

Railroads in Indo-China

Trade Commissioner THOMAS BUTTS, Paris, France (U. S. Commerce Reports)

THERE are 2,389 kilometers (1,485 miles) of railroads open to public traffic in French Indo-China, which are divided into three groups comprising the Northern and Annam Railway, the Southern Railway, and the Compagnie Francaise des Chemins de Fer de il'Indochine et du Yunnan. The first two groups are operated by the colony and managed by a chief engineer who is directly under the orders of the General Inspector of Public Works of French Indo-China. The Chemins de Fer de l'Indochine et du Yunnan is owned by the Government but is leased to a private company. European personnel hold the more responsible posts; those of lesser importance are filled by the natives.

A certain sum is set aside in the Government budget each year to supplement the receipts of the railways, over and above that allocated for new construction and development.

New Railway Construction Program

In 1912 a 90,000,000-franc loan was floated for the purpose of carrying out a railway-construction program which would link up the various Provinces. The first part of this program, namely, the extension of the Hanoi-Dongdang line to No-Cham, was carried out without much difficulty. The second part, the construction of a line joining up the north with the center, was delayed by the war. Work was begun again on this section after 1920 and finished a few years ago.

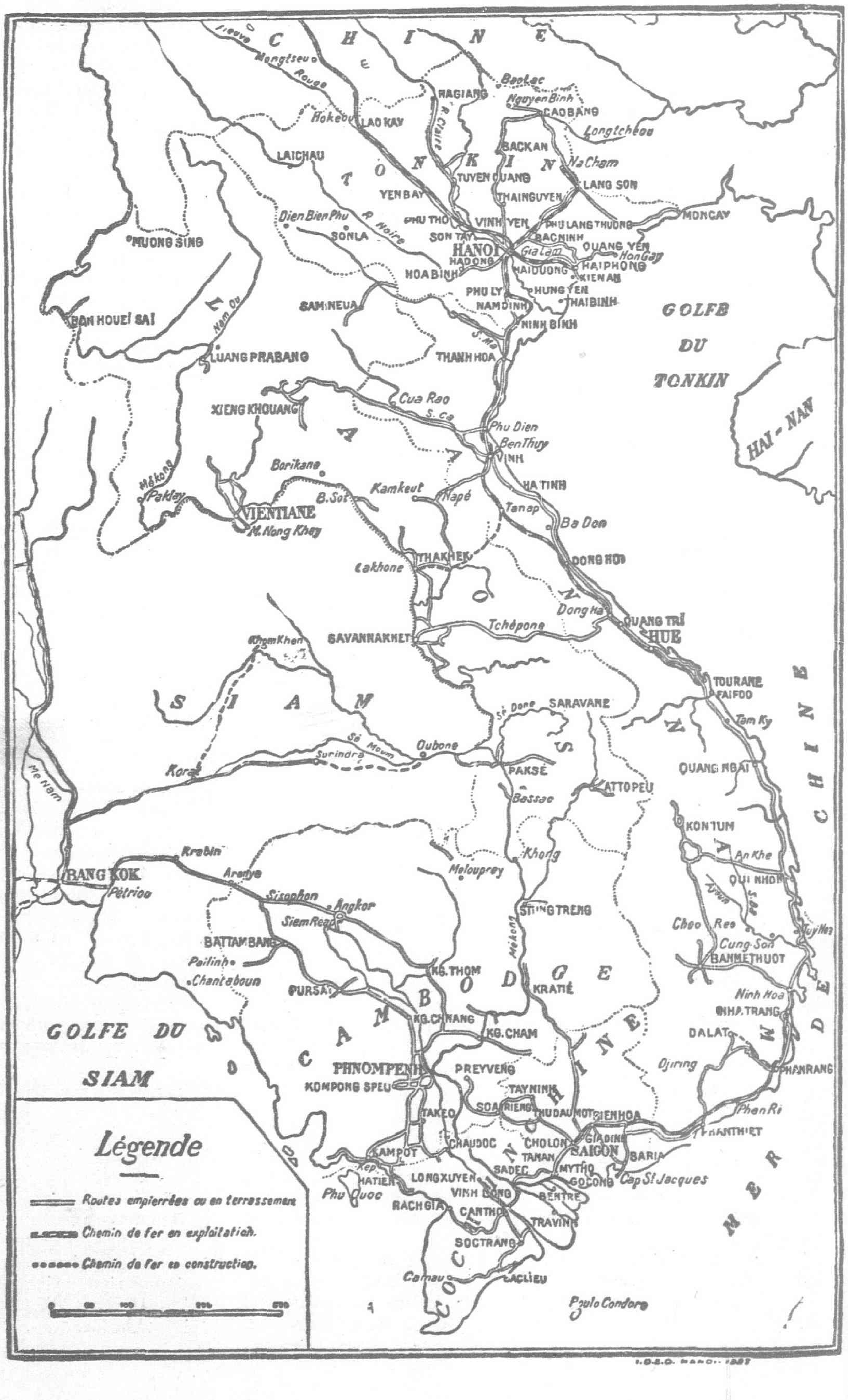
Since 1921 the Government of Indo-China has been studying a new railroad program. The development of the railroads existing at that date could not have been sufficient to meet the growing economic needs of the colony.

The new program includes the construction of the following lines:

1. Form Tanap to Thakhek, linking up the navigable reach of the Mekong River with the Trans-Indochinese Railway, a distance of some 186 kilometers (115½ miles). Work on this railroad has been commenced.

2. From Tourane to Nha-Trang, a distance of 550 kilometers (341¾ miles). This projected line could fill the last gap in the Trans-Indochinese Railway and allow the free importation of labor from the over-populated northern districts into Cochin China, for the more rapid development of the great agricultural resources of that Province. The two obstacles to be overcome are the Varella mountain chain, which would necessitate the boring of several tunnels; and the Song-Drang delta, which would have to be spanned by three bridges having a total length of 1,200 meters (3,937 feet).

3. From Saigon to Pnom-Penh and the Siamese frontier. This line is necessary for the development of the fertile regions in North Cochin China and western Cambodia. Furthermore, this line would link up the Indo-Chinese system with the Siamese railways and establish communications between Bangkok and Saigon. The first obstacle to the overcome is the Mekong and the flood area around that river, covering a width of some 40 kilometers (nearly 25 miles).



4. The Mytho-Vinhlong-Cantho-Baclieu line, within the boundaries of Cochin China, is of less importance than the three already mentioned by would be of considerable local value.

The need for carrying out all the construction work described above is recognized to be urgent, and it will be undertaken as soon as sufficient funds are available.

Construction Details

The gage of all the Indo-Chinese railways is 1 meter (3.28 feet). Gradients never exceed 1 in 40, and the radii of the curves are never less than 100 meters (328 feet); except on the line Lokay-Yunnaniou and on some parts of the Mytho-Dalat line, the radii of the curves are never greater than 15 millimeters per meter (0.18 inch to the foot).

The type of locomotive most used is a 3-wheel coupled, weighing empty about 30 tons, and capable of hauling 300-ton trains at 40 kilometers (nearly 25 miles) an hour.

The steel Vighole rails are laid on broken-stone ballast 19⅝ inches thick and 8 feet 2½ inches wide on top. They are from 26 feet 3 inches to 39 feet 4 inches in length and, according to type, weigh from 13.4 to 18.1 pounds per foot run.

The fishplates, generally of a current type and weighing from 12.1 to 13.2 pounds, are attached to the rail by four bolts in a single row.

Steel ties are used on the Yunnan line and on some parts of the other lines. Otherwise, wooden ties are used, as they are considerably cheaper. They are generally 5 feet 8⅞ inches by 7 inches by 4¾ inches and spaced fairly close together. The rails are coach-screwed directly onto them without any sole-plates.

All the lines are single track and traffic is light; signals and signal regulations, therefore, are simple.

Passenger Traffic Affected by Road Transport

Most of the passenger trains are divided into four classes: First, second and third classes, used by both Europeans and natives; and fourth class, used by natives only.

From the beginning the railways were popular with the natives, and the native passenger traffic even in the first years of operation was surprisingly heavy. Until 1920, with the exception of the war years, the passenger traffic increased regularly. Since 1921, however, it has decreased with equal rapidity, owing to the competition offered by the fast-developing automobile transport. As the natives use the railways only for short trips, from one village to another, from home village to market, it has been a simple matter to organize automobile services to take the place of the train. However, it is thought that when the railway system is completed and north and south linked up, the passenger traffic will increase considerably, owing to emigration from the overpopulated northern districts to the south where labor is comparatively scarce and better paid in consequence. Recently, also the railway companies have reduced their passenger tariff, and far better results were obtained last year in both number of passengers and actual receipts.

Freight Traffic has Increased

The freight traffic has increased constantly since 1912. Of the merchandise chiefly carried by the railways the most important are: On the Northern railway, rice, paddy, and construction wood; on the Southern railway, construction wood and semifinished wood products; on the Yunnan railway, fabrics, textiles, iron and steel.

During 1928 the three systems carried 1,164,136 metric tons of freight (1,142,723 metric tons in 1927) and 11,327,071 passengers (10,592,042 in 1927), according to a report from Consul Henry S. Waterman, Saigon.

Revenues in 1928 totaled 9,944,656 piasters (8,305,500 piasters in 1927), and expenditures 8,474,353 piasters (7,010,385 in 1927). (The piaster has a current exchange value of about $0.39.)

The present situation and prospects of the Indo-Chinese railways may be said, on the whole, to be rather favorable. Although up to the present time the net profits have not been sufficient to allow development at the rate that would fully meet the demand, the fairly constant progression in profits realized is such that the railways should soon be on a better footing. It must be remembered also that the chief reason for these small profits is the fact that rates charged are extremely low, and profits must therefore be looked for from other sources that naturally attend the general economic development as assisted by the railways.

Rolling Stock

In the past few years it has been necessary to make large purchases of rolling stock, and an extensive program of purchases was drawn up at the end of 1928, covering a period of four years.

Rolling stock in operation on all lines at the end of 1928 comprised 227 locomotives, 496 passenger cars 2,609 freight cars, and 301 construction and maintenance-of-way cars.

New Bridges for the Philippines

Continued from page 329).

the Sangay river bridge, the Sicaba river bridge, and the Himogaan river bridge.

Two in Oriental Negros, the Guihulñgan river bridge and the Ayungon river bridge; Camarines Sur with two bridges, the Bicol river bridge, and the Agus river bridge; two in Ilocos Sur, the Abra river bridge, and the Amburayan river bridge; two in Cagayan, the Pinacanauan and the Pared river bridges; two in Leyte, the Calogcog and the Daguitan river bridges.

One in Davao, the Talomo river bridge, another in Nueva Ecija, the Peñaranda river bridge. In Misamis, the Cagayan river bridge; Balsic river bridge in Bataan; Indiana river bridge in Nueva Vizcaya, Borogan river bridge in Samar; Agus river bridge in Lanao, Mambusao river bridge in Capiz, Caybacon river bridge in Sorsogon, Kalaklan river bridge in Zambalez, Bancag river bridge in Abra, Badoc river bridge in Ilocos Norte, Sapang river bridge in Pangasinan, and Magasawang Tubig river bridge in Mindoro.

The construction of 18 bridges of the 34 in the project has been authorized by Filemon Perez, secretary of commerce and communications. These projects have been awarded by the public works to different constructors who are actively proceeding with their work.

Director Williams announced that bids will be advertised at an early date for the construction of the Agus bridge in Lanao, Calogcog bridge in Leyte, the Mambusao bridge in Occidental Negros and the Caybacon bridge in Sorsogon. The plans and specifications for these five projects have already been prepared by the engineers in the designing division and approved by Mr, Williams.

Plans for the other ten bridges included in the project are now under advertisement of the designing division of the public works. These are the Calao bridge in Isabela, Pinnacanauan bridge in the same province, the Pinacanauan bridge in Cagayan, Kalakla bridge in Zambalez, Bancag bridge in Abra, Badoc bridge in Ilocos Norte, Sapan bridge in Pangasinan, Magasawang tubig bridge in Mindoro, Guihulñgan bridge in Oriental Negros and the Daguitan bridge in Leyte.

The type of construction of these bridges included in the bridge project for this year differs from concrete type to steel structure spans.—(*Manila Bulletin.*)

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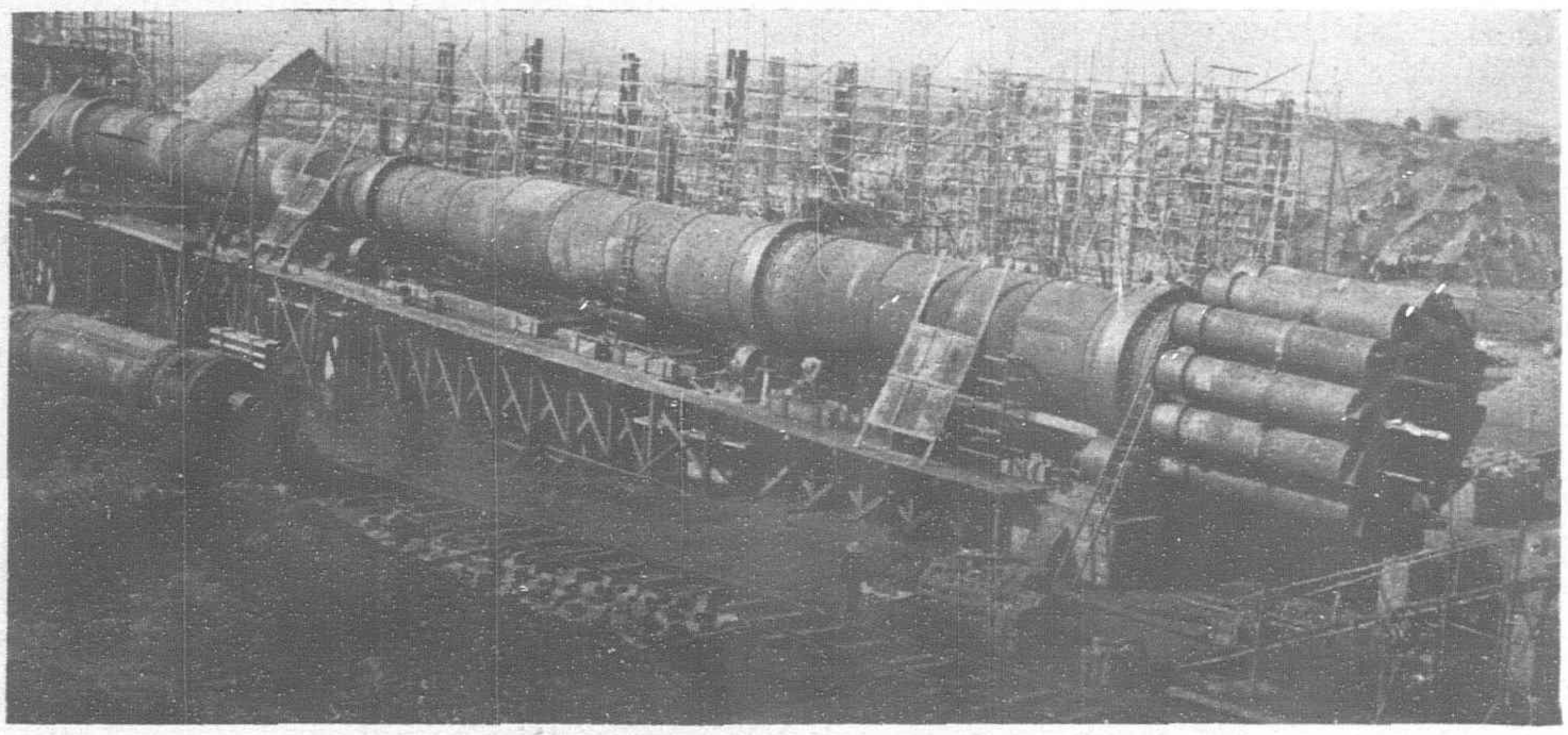

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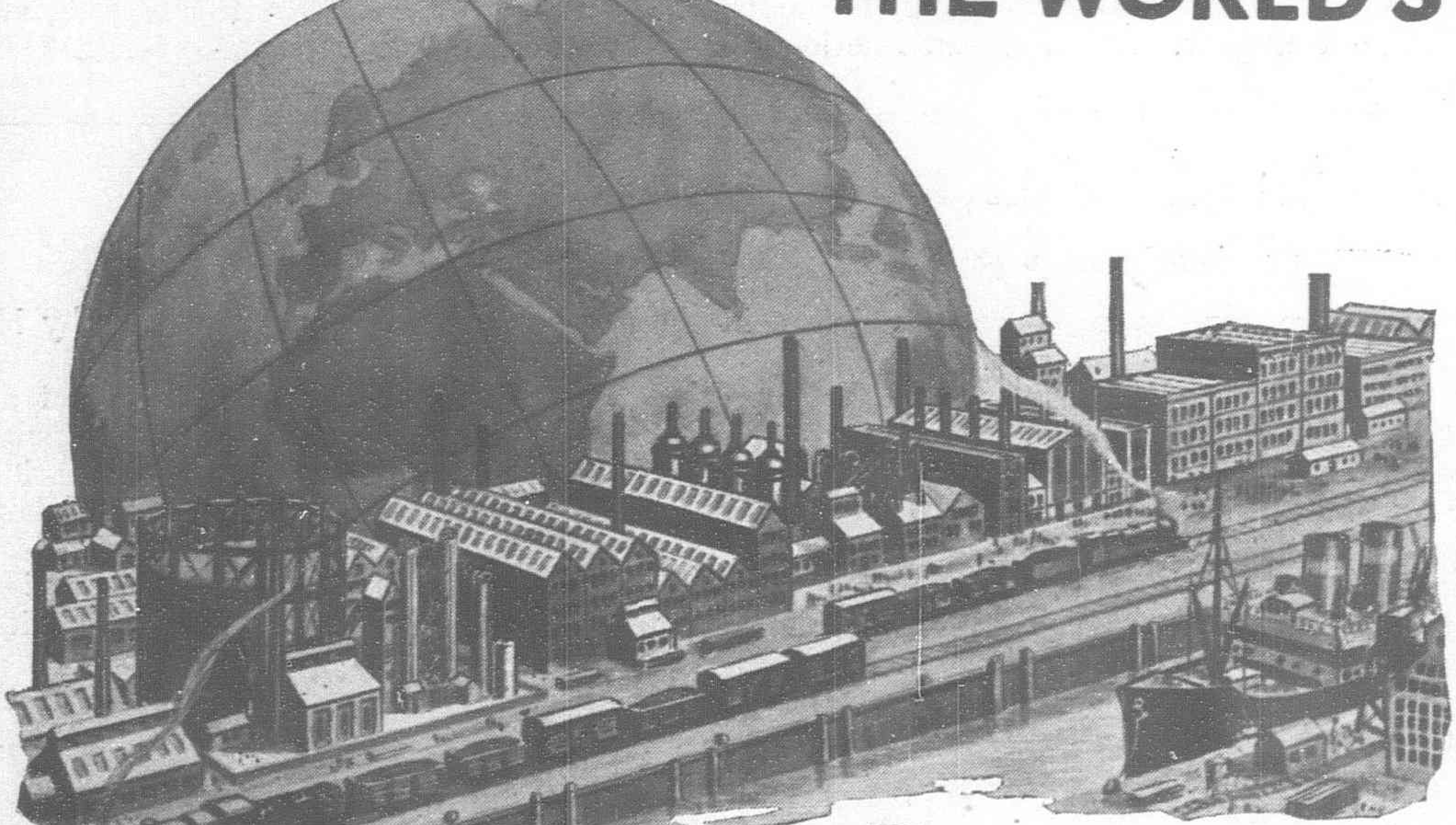

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